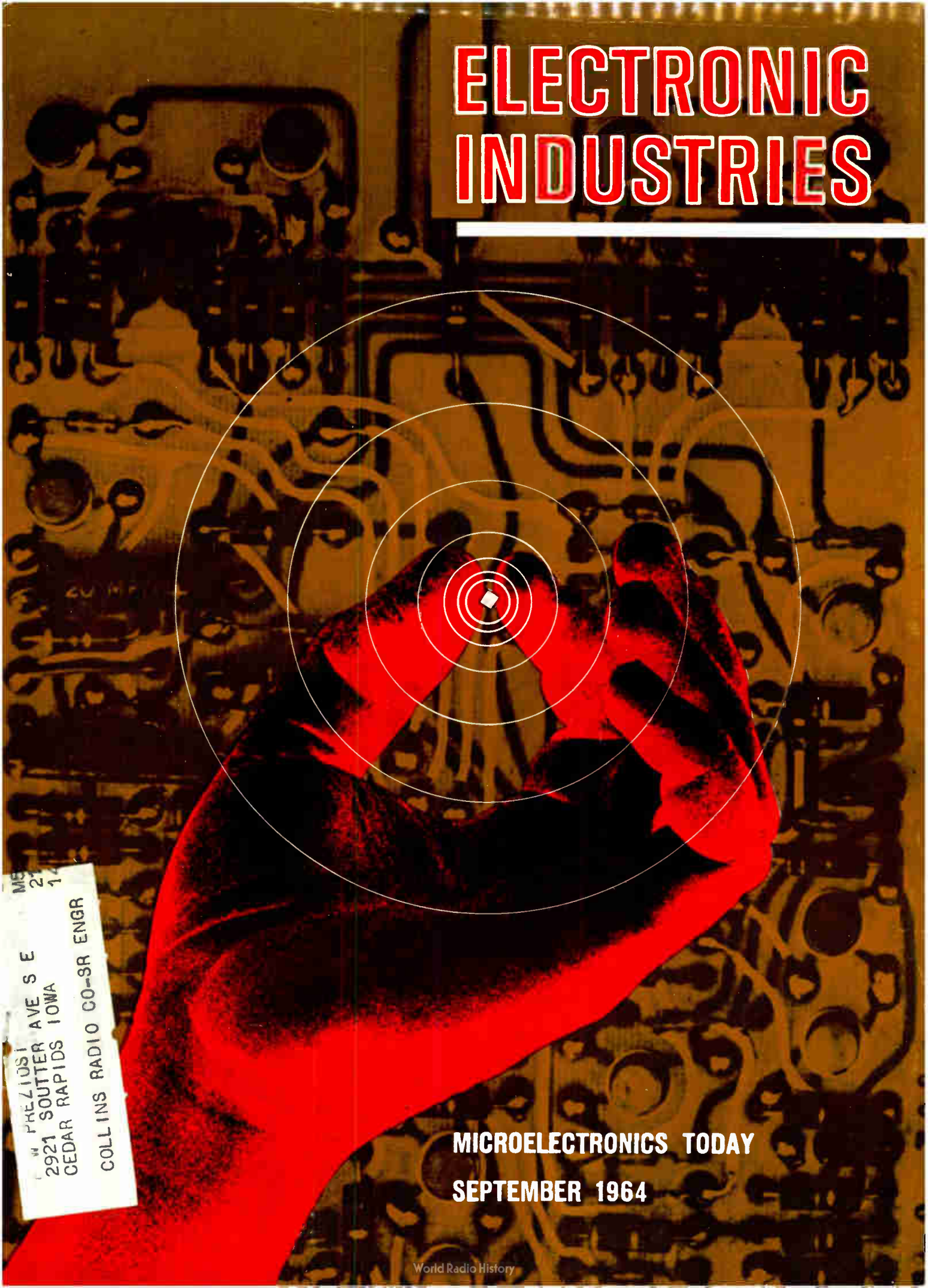
ELECTRONIC INDUSTRIES



MICROELECTRONICS TODAY

SEPTEMBER 1964

COLLINS RADIO CO-3R ENGR
2921 SOUTTER AVE S E
CEDAR RAPIDS IOWA

World Radio History

HI-FI

Transistor output; matches any PP transistor to 4, 8, 16 Ω speaker. Primary 48, 36, 12 Ω C.T.; 20 — to 20 KC; 40 watts.

MINIATURE MIL TYPE

Metal case hermetically sealed to MIL-T-27B. Gold Dumet leads spaced on 0.1 radius, for printed circuit application.

CHOPPER

Magnetic shielded plus electrostatic shield for voltage isolation of 2×10^6. Primary 200K C.T. to within 0.1%. Secondary 50K.

HIGH PDWERED AUDIO

Low distortion 2.5 KW output transformer. PP 450 TH's 18,500 ohms C.T. to 24 6 ohms, 20 KV hipot. 520 lbs.

CATHODE FOLLOWER OUTPUT

Provides equal voltages to 5 loads. Primary inductance maintained to 5% with 20% change in DC unbalance and 30% change in AC voltages.

HI-FREQUENCY CARRIER TO MIL-T-27B

Electrostatically shielded, humbucking. +30 dbm level. Within .5 db 250 cycles to 110 KC. 600-135-600 centertapped to .1% tolerance.

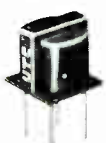
HYBRID TRANSFORMER

Two transformers each 600 Ω primary. 40K Ω C.T. secondary 250 cycles to 5 KC within ¼ db. 40 db isolation over band.

MICROMODULE

Life tested per micromodule specs.: no failures. 10K Ω C.T. to 10K Ω, 100 mw from 400 — to 20KC.

SUBMINIATURE MOLDED TRANSFORMER



Grade 3 with printed circuit leads for transistor application. 150 Ω to 150 Ω at 10 dbm level. Size ½ x ½ x ½"; weight 5 grams.

BOLOMETER TRANSFORMER

Primary 10 ohms, secondary 530K ohms, 230:1 ratio, response from ½ cycle to 25 cycles. 120 db magnetic shielding, plus full electrostatic shielding.

ULTRA-MINIATURE

Electrostatically & magnetically shielded output transformer 5/16 D. x ¼" H. Pri. 15K CT, Sec. 8K CT; max. level 50 mw; audio range response. To MIL-T-27B, grade 4.

UTC™ PIONEERS IN MINIATURIZATION

SPECIAL (CUSTOM BUILT)

AUDIO TRANSFORMERS

TO YOUR SPECIFICATIONS

Exceptional quality and reliability is provided in all UTC designs. Over 30 years of engineering knowledge and experience substantiated by extensive field performance assure the highest quality and most reliable components in the industry. Complete environmental testing facilities are incorporated to prove out new designs. Full analysis and evaluation of materials are conducted in UTC's Material and Chemical Laboratories. Rigid quality control measures coordinated with exhaustive statistical findings and latest production procedures results in the industry's highest degree of reliability. Range covered in Audio Transformers is from 0.1 cycles to 400 MC . . . microwatts to 50 KW.

MILITARY AND COMMERCIAL TYPES FOR EVERY PHASE OF THE ELECTRONICS ART

POWER TRANSFORMERS • AUDIO TRANSFORMERS • INDUCTORS • PULSE TRANSFORMERS • ELECTRIC WAVE FILTERS • LUMPED CONSTANT DELAY LINES • HIGH Q COILS • MAGNETIC AMPLIFIERS • SATURABLE REACTORS • REFERENCE UNITS

Write for catalog of over 1,200 UTC HIGH RELIABILITY STOCK ITEMS IMMEDIATELY AVAILABLE from your local distributor.

UNITED TRANSFORMER CORP.

150 VARICK STREET, NEW YORK 13, N. Y.

PACIFIC MFG. DIVISION: 3630 EASTHAM DRIVE, CULVER CITY, CALIF.
EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y. CABLE: "ARLAB"

Circle 1 on Inquiry Card

World Radio History

WHOSE RESPONSIBILITY IS CONVERSION?

DEPARTMENT OF DEFENSE OFFICIALS will not concede that DOD has a responsibility to support defense contractors. This decision may be justified from an economic viewpoint but it is no help to the industry at large.

The electronic and other defense industries were recruited in a crash program to develop the weapons systems we now have in our arsenal. As the requirements grew, so did the firms. Over the past ten years, the electronic industries have grown like topsy, and at every step, their moves have been dictated by military emergencies.

Rightly or wrongly, defense contractors have come to regard the defense business as a permanent way of business life. They could not have provided the high level of engineering performance which the military demands had they thought otherwise.

In spite of this background, it is still difficult to find an answer when Eugene G. Fubini, DOD Ass't. Secretary for Defense & Research, asks, "Is Defense business to be the sole U. S. business where a 5% cut creates panic?"

This may well be the natural result when a firm has only one customer. And conversely, that single customer has an obligation to the supplier unlike any other in the normal free enterprise supply-and-demand relationship. A 5% decline in business may very well wipe out the firm's slim profits, and the loss cannot be compensated for by increasing business from other quarters.

We believe that DOD should accept some responsibility for the future of defense-oriented electronic firms. If the aid cannot be provided in the form of contracts, then strenuous efforts should be made to assist the industry in its transition to commercial-industrial work.

In the past, DOD has made some effort by helping local areas, such as Wichita, Kansas, to readjust to the closing down of a defense installation. However, DOD's efforts here generally are limited to "too little and too late."

Some Congressmen are becoming aware of these problems and several have introduced bills. One, by Sen. George McGovern (D., S. Dak.) urges the creation of a National Economic Conversion Commission, responsible "for drafting a blueprint of appropriate actions by departments and agencies of the Federal Government to facilitate conversion."

However, passage of this bill is, at best, uncertain. In the meantime, electronic defense contractors and unemployed engineers need immediate aid as defense programs are being modified, reduced, or dropped. In an earlier editorial we called attention to the need for an "Electronic Industries Capabilities Center" to help defense contractors display and demonstrate their products and services to other non-defense industries.

Concurrently, Battelle Memorial Institute economists are working under a $107,000 contract from the U. S. Arms Control and Disarmament Agency to study implications of reduced defense demand for electronic industries. This study, which is utilizing market research facilities of ELECTRONIC INDUSTRIES Magazine, analyzes problems and opportunities under reduced defense demand.

Recently, a revealing report on this subject was released by Corplan Associates, management consultants, an affiliate of IIT Research Institute in Chicago. This study is aimed to help the Chicago area keep ahead of technological change. Growth figures projected for 1980 in the Chicago area include:

—Employment in printing and publishing to rise 11% to 90,931.

—Employment in office industries to rise to 770,000 from 510,000.

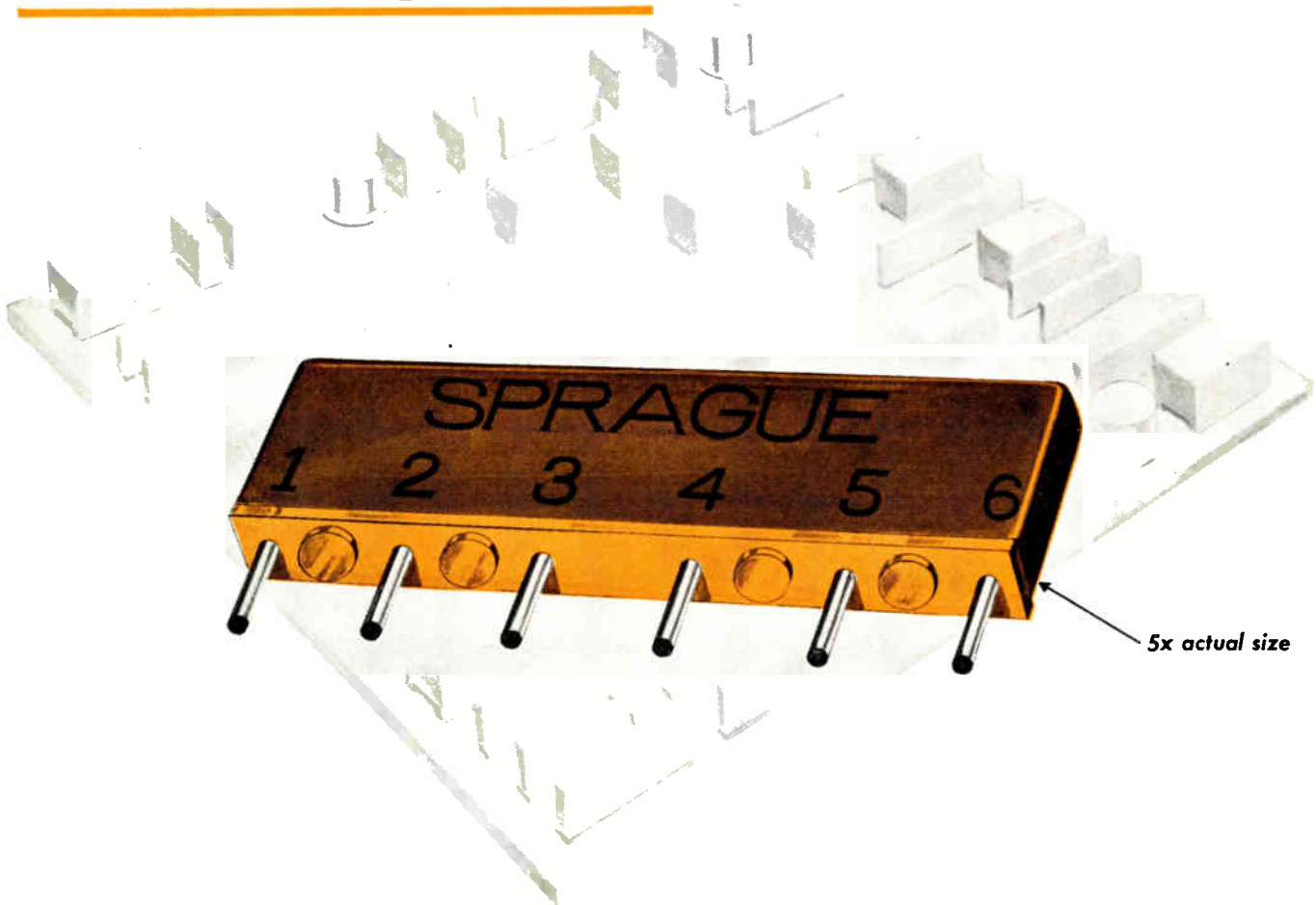
—Employment in metalworking industries to rise from 492,300 to 540,000.

These gains offer new growth potentials for products and systems made by electronic defense firms. However, this report studies only one area of the United States. We feel that an overall coordinating group is required to integrate the present findings of Corplan, with the future findings of Battelle. We feel such a comprehensive project could be done by the Department of Commerce, financed by the Department of Defense. Above all, a nation-wide program should be developed and based upon inter-regional studies. Such a national blueprint could chart new guidelines to help spur future growth for the electronic industries.

Bernard F. Osbahr

World Radio History

New from Sprague!



METANET* TRUE METAL-FILM PRECISION RESISTOR NETWORKS

Save Space, Time, and Money

- High packaging density—4 to 8 times that of individual components.
- Fewer components to stock, handle, inspect, install. Entire module can be hand-inserted faster than one axial-lead component.
- Permit substantial savings over equipment assembled with individual components.
- Epoxy terminal board keeps pin terminals free of resin coating, unlike conventional dipped components, and provides uniform lead spacing.
- Stand-off bosses permit efficient flux removal after soldering. Also prevent dirt and moisture traps around leads.
- Extremely stable and reliable. Meet performance requirements of MIL-R-10509D. Resistance tolerances to ±1%.
- Ceramic capacitors can be incorporated for further savings and size advantages over individual components

• • •

For complete information write to Integrated Circuit Application Engineering Dept., Sprague Electric Company, 233 Marshall St., North Adams, Massachusetts 01248

*trademark

SPRAGUE COMPONENTS

RESISTORS	PULSE TRANSFORMERS	CERAMIC-BASE PRINTED NETWORKS
CAPACITORS	INTERFERENCE FILTERS	PACKAGED COMPONENT ASSEMBLIES
TRANSISTORS	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

45M 17-63R1

SPRAGUE®
THE MARK OF RELIABILITY

'Sprague' and '②' are registered trademarks of the Sprague Electric Co.

World Radio History

September 1964, Vol. 23, No. 9

ELECTRONIC INDUSTRIES

The STATE-OF-THE-ART* Magazine for Electronic Engineers

COVER

Tiny white square typifies a microelectronic package that could replace the circuit board shown in the background. This issue contains five timely articles dealing with microelectronics. These articles start on the following pages: 32; 64; 68; 73; and 146.

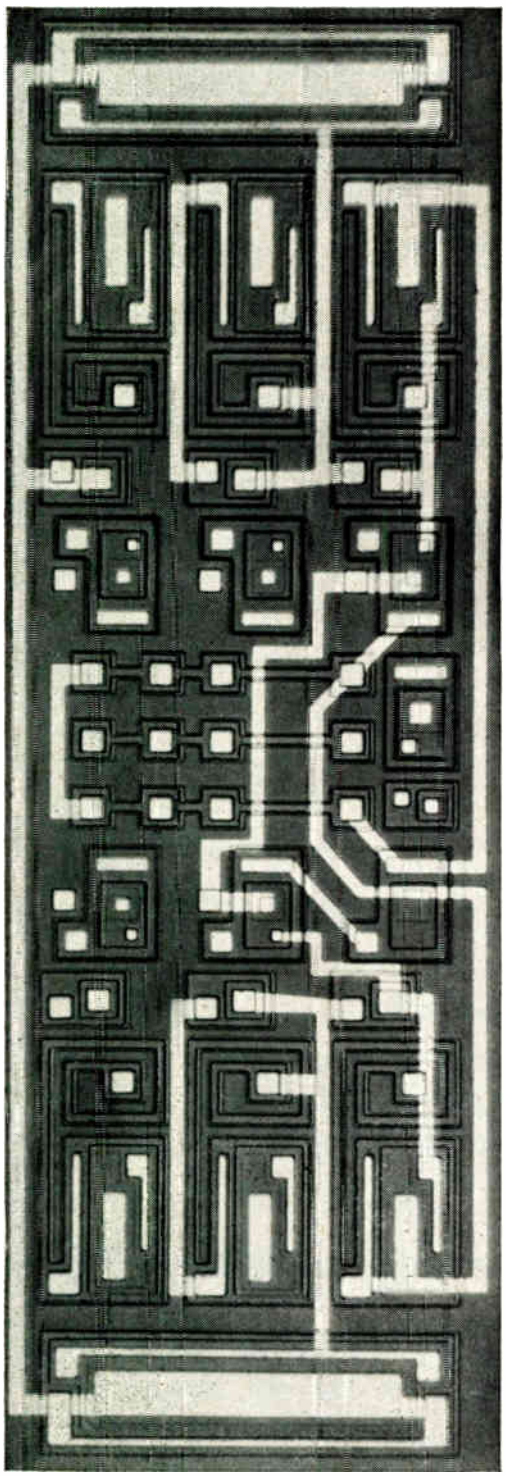
*STATE-OF-THE-ART: up-to-the-moment capability in each area of electronic technology

BPA NBP

DEPARTMENTS

World Radio History

Now from Sprague!



UNICIRCUIT®
INTEGRATED CIRCUITS

actual size

This is a master-matrix UNICIRCUIT, interconnected to meet the requirements of a military systems manufacturer for an RS flip-flop. The photograph at the left, enlarged 38 diameters (1444 times area), speaks for itself as to the technical capability of the Sprague Electric Company to produce complex silicon monolithic integrated circuits.

If you would like to discuss your integrated circuit needs with an old-line established electronic components manufacturer who has a proven reputation for reliability, please write or telephone Mr. Albert B. Dall, Marketing Manager, Semiconductor Division, Sprague Electric Company, Concord, New Hampshire. *area code 603 Tel. 224-1961*

SPRAGUE COMPONENTS

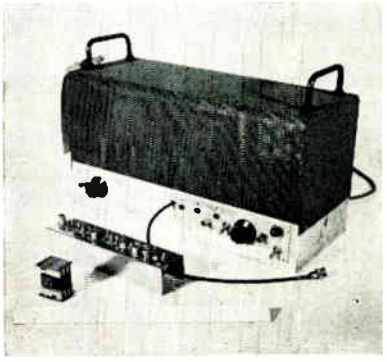
INTEGRATED CIRCUITS	PULSE TRANSFORMERS	CERAMIC-BASE PRINTED NETWORKS
THIN-FILM MICROCIRCUITS	INTERFERENCE FILTERS	PACKAGED COMPONENT ASSEMBLIES
CAPACITORS	PULSE-FORMING NETWORKS	BOBBIN and TAPE WOUND MAGNETIC CORES
TRANSISTORS	TOROIDAL INDUCTORS	SILICON RECTIFIER GATE CONTROLS
RESISTORS	ELECTRIC WAVE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

SPRAGUE®
THE MARK OF RELIABILITY

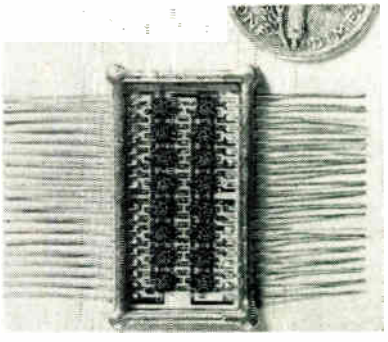
'Sprague' and '②' are registered trademarks of the Sprague Electric Co.

World Radio History

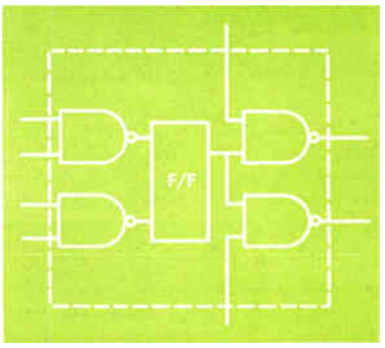
ELECTRONIC INDUSTRIES HIGHLIGHTS



Microelectronics



Thin Films Today

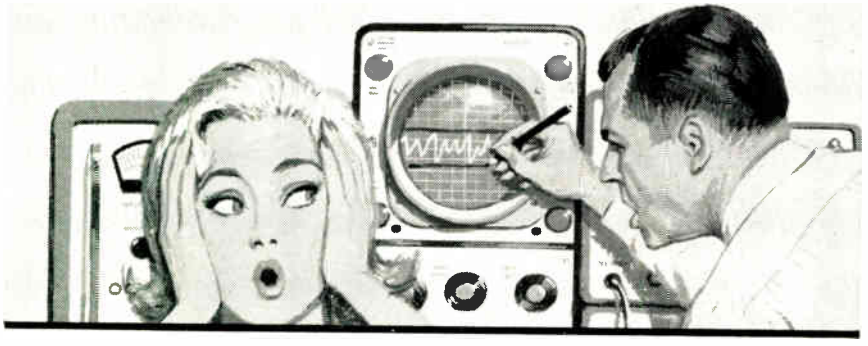


Integrated Circuits

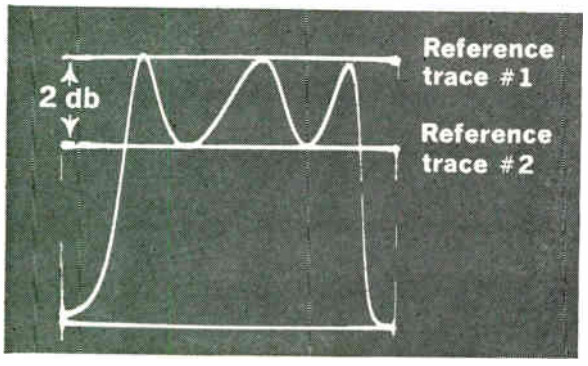
Message Switching Centers

World Radio History

END GREASE-PENCIL GUESSWORK IN PRODUCTION MEASUREMENTS



NEW JERROLD 890 SWEEP GENERATOR and TC-3 COAXIAL SWITCHER



Typical network rf loss displayed with upper and lower limits by Jerrold 890 Sweep Generator and TC-3 Coaxial Three-Way Switcher.

This new medium-priced team lets you throw away your grease pencil—and all your troubles with drift and inaccuracy. It provides precise, drift-free electronically-produced upper and lower limits.

The Model 890 Sweep Generator has a frequency range from 500 kc to 1,200 mc, and offers sweep widths from 100 kc to 200 mc. Extremely stable output.

The solid-state TC-3 Coaxial Switcher (frequency range 0 to 1,200 mc) features three-position operation, enabling the insertion through variable attenuators of two reference traces in addition to the test trace.

Write for free brochure explaining details of this and other applications of comparative sweep techniques. Ask for demonstration.

Model 890 Wide-Band Sweep Generator. Price $825.

Model TC-3 Solid-State Three-Position Coaxial Switcher. Price $295.

JERROLD ELECTRONICS

Industrial Products Division, Philadelphia, Pa. 19132

SWEEP GENERATORS • PRECISION ATTENUATORS • AMPLIFIERS • COMPARATORS

ELECTRONIC INDUSTRIES

SHELBY A. McMILLION, Publisher

BERNARD F. OSBAHR, Editor

CREIGHTON M. MARCOTT
Executive Editor

JOHN E. HICKEY, Jr.
Managing Editor

SMEDLEY B. RUTH
SIDNEY FELDMAN
Associate Editors

JOHN J. HUNTER
ROBERT J. BRAMLETT
Assistant Editors

DR. ALBERT F. MURRAY
Consulting Editor

ELMER KETTERER, Art Director

ANNE AXE, Editorial Assistant

ANN LAVENDER, Research Assistant

MAE MOYER, Reader Service

IDA GOOD, Editorial Secy.

EDITORS-AT-LARGE

Eastern Region

ELMER T. EBERSOL,
100 East 42nd St.
New York 17, N. Y.
(Area Code 212) OXford 7-3400

Western Region

J. PHILIP GEDDES,
198 S. Alvarado St.
Los Angeles 57, Calif.
(Area Code 213) DUnkirk 7-1271

Defense/Space

CHARLES R. WILHIDE,
Pentagon News Room
The Pentagon
Washington, D. C.

WASHINGTON NEWS BUREAU

1093 National Press Bldg.
(Area Code 202) 393-3474
TWX—202 965-0675

GEORGE BAKER, Mgr.
NEIL R. REGEIMBAL

BUSINESS DEPARTMENT

ELMER DALTON
Advertising Promotion & Circulation Manager

EDWARD G. SHAUD, Jr.
Marketing Manager

ARA H. ELOIAN
Production Manager

See Advertisers Index on page 155 for Regional Sales Managers.

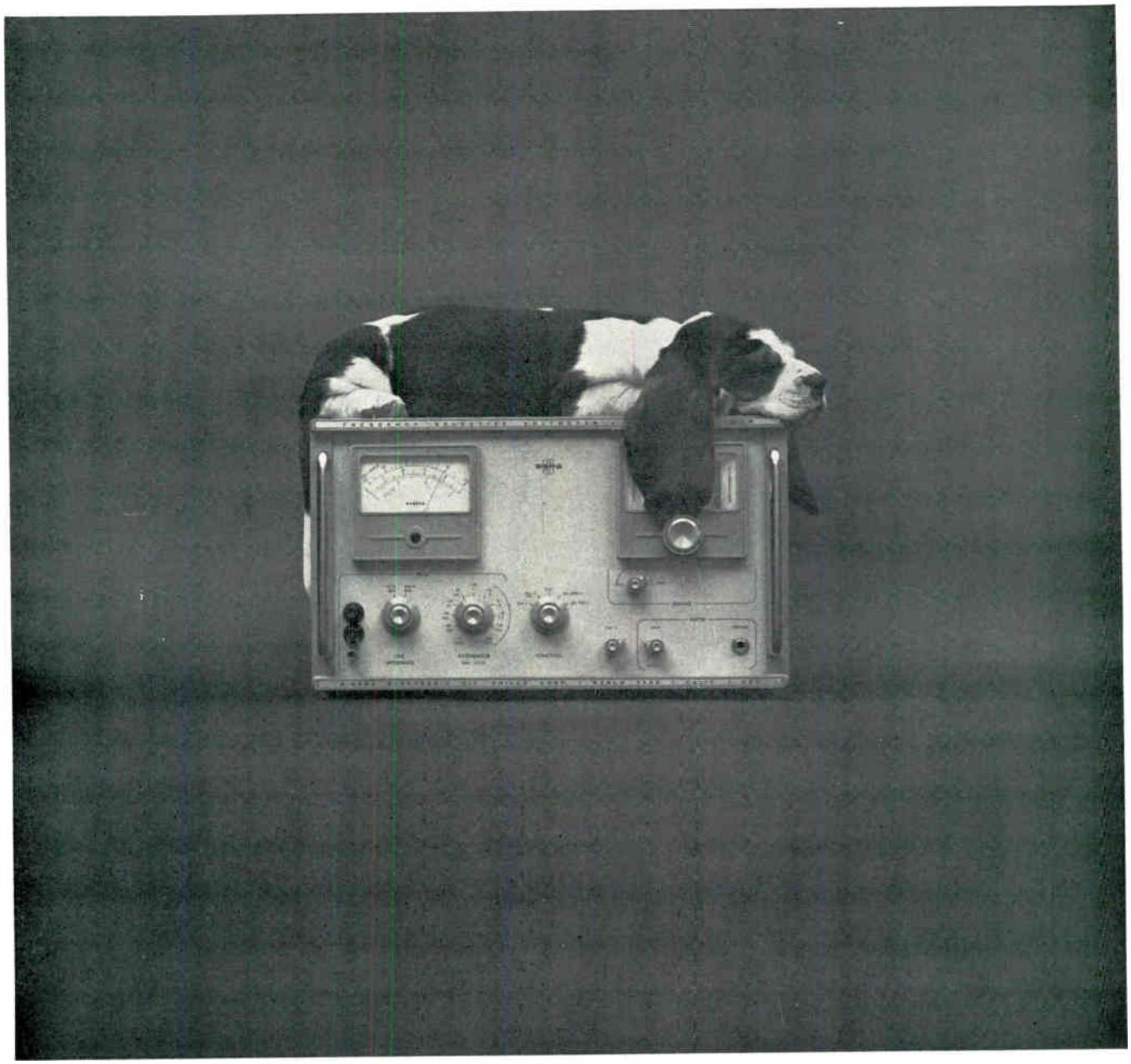
Chilton Company—G. C. BUZBY, President. Executive Vice Presidents: R. E. McKenna, G. T. Hook. Vice Presidents: P. M. Fahrendorf, L. V. Rowlands, M. E. Cox, E. B. Terhune, Jr., R. W. Case, Jr., J. H. Kofron. Treasurer: Stanley Appleby. Secretary: J. A. Montgomery. Other Directors: C. A. S. Heinle, G. E. Cameron, T. C. Campbell, H. W. Barclay, W. A. Phair; Assistant Treasurer: J. Miades; Assistant Secretary: I. C. Holloway.

JOHN H. KOFRON
Chilton Research Director

ELECTRONIC INDUSTRIES, September, 1964. Vol. 23, No. 9. A monthly publication of Chilton Company, Executive Editorial & Advertising offices at Chestnut & 56th Sts., Phila., Pa. 19139. (Area Code 215) SHerwood 8-2000. Controlled circulation postage paid at Philadelphia, Pa. $1 a copy; Reference Issue (June), $5.00 a copy. Subscription rates U. S. and U. S. Possessions: 1 yr. $10.00; 2 yrs. $18.00. Canada 1 year, $12.00; 2 yrs. $20.00. All other countries 1 yr. $18.00; 2 yrs. $30.00.

Copyright 1964 by Chilton Company. Title Reg. U. S. Pat. Off. Reproduction or reprinting prohibited except by written authorization.

World Radio History



Sierra is a Warm Voltmeter

This is the frequency selective voltmeter that took "voltmeter" out of the language of telephone company maintenance engineers. To them, it's a "Sierra." You'll find them keeping their Sierras warm through constant use: tracking down fugitive harmonics; tracing out complex wave forms; performing the numerous check-out functions required to keep complex carrier equipment humming.

Telephone people have been using Sierras since 1947, the year the line was born. Some have been using the same instrument for 16 years. One of the early '47's came in recently with its first request for service! The same kind of lasting power is being built into this year's models.

Today Sierra means more than voltmeters. It could be the assurance of power levels measured on an r-f calorimeter that sets industry standards for accuracy. Or the security of a transistor passed through quality control after a thoroughgoing physical in a power transistor tester. More than a half-hundred meanings of the word Sierra can be found in the pages of the Quick Reference Catalog.

There's a Sierra Electronic Division to define, too. It's the builder of precision electronic test instruments, backed by the engineering resources of Philco Corporation and the Ford Motor Company. And it's a reputation, backed by 16 solid years of performance, for building superb products from soundly conceived designs . . . without compromise.

The Quick Reference Catalog presents basic information on the products of Sierra Electronic Division of Philco. Ask for your free copy by writing to the address below.

SIERRA ELECTRONIC DIV.
OF
PHILCO
A SUBSIDIARY OF Ford Motor Company

Sierra Electronic Division/ 3879 Bohannon Drive/ Menlo Park, California

World Radio History

ELECTRONIC INDUSTRIES RADARSCOPE

Analyzing current developments and trends affecting the State-of-the-Art of technologies throughout the electronic industries

POWERFUL X-RAY 'EYE'

A new X-ray system, so powerful it can "watch" shifting patterns of atoms during making of man-made materials such as diamonds, has been developed at Westinghouse laboratories. System was developed for Air Force Cambridge Research Laboratories to study structural changes in crystalline materials under high temperatures, pressures.

MAGNETOHYDRODYNAMIC GENERATORS for use with NASA's space-born nuclear reactors may now be operated at temperatures as low as 2,200°F. according to research at GE's Space Sciences Laboratory, Valley Forge, Pa. An advanced concept used in recent tests involves pre-ionization of gas plasma with a high voltage beam. Argon seeded with less than 1% cesium was used, heated to 2200°F.

TW MASER DEVICE, announced by Toshiba (Tokyo Shibaura Electric Co., Ltd.) makes possible reception of sharp, stable color TV signals in the lower levels of the 4,000MC band. The new device uses a synthetic ruby comb-type delay structure for greater amplification (40 db gain) and Yttrium Iron Garnet.

COHERENT RADIATION in the blue-green region has been achieved through continuous and pulsed visible laser action in pure argon. Previously green light was generated by harmonic interaction between a laser beam and some material. W. B. Bridges, Hughes Research Laboratories, obtained pulsed operation of the argon laser. E. I. Gordon and E. F. Labuda, Bell Laboratories, developed the continuous action.

DECADE COUNTER, the first fully integrated, has been developed for use in counting, timing, programming and commutation by Honeywell, Inc. The firm's semiconductor development staff at Riviera Beach, Fla., has fabricated a 10-stage ring counter containing 59 components on a monolithic silicon chip.

INDUSTRIAL ELECTRONIC DEVELOPMENTS

Infrared back-scatter moisture gage for on-line laboratory measurement of water in paper has been developed by the General Electric Co. The new moisture monitoring gage can be used as a contacting or non-contacting instrument; it measures for water content rather than inferring for moisture content from other properties. It uses a two wavelength IR system. One wavelength is in an absorption band and is not affected by the water content. Ratio of reflected energy in the two bands is measure of the paper's water content. . . .

Low-cost data transmission and recording system specially suited for factory use is announced by Advance Data Systems Corp., division of Litton Industries. Called Data Dial System, it will allow factory employes to report information to foremen and production supervisors in an instant by dialing on standard telephones. A printed record of the data is made on teletype, adding machine, or a recording device at the collection point for all data dialed by workers. At the same time, an 8-channel punched paper tape is made for later analysis by computer. . . .

Electronic monitoring system developed by RCA can maintain an automatic check on a thousand miles or more of communications cable. It can detect any point of failure with a few feet, the firm reports. The new cable "sentinel"—called Remote Cable Pressure Monitoring System—can operate from a single terminal station and print a record of its findings. . . .

Microscopic holes can be drilled in metal as hard as tungsten with a new laser technique, another RCA development. Researchers used a ruby laser beam to drill in tungsten wire a series of holes as small as 1/10,000th of an inch. Burton Clay, project engineer, said the laser drilling application could lead to extremely compact and fast microenergy memory units for computers. . . .

Closed-circuit TV and a stroboscope are used in a special technique to test variable-pitch ejectable propellers at Dowty Totol Ltd's Gloucester (England) plant. The system is supplied by EMI Electronics, Ltd. A strobe "freezes" the propeller at a known speed. Light from the strobe is reflected along the line of sight of the TV camera by a polished stainless steel sheet with a central hole through which the camera is focused. The camera sees the blade in its plane of rotation and an image of the blade root is clearly seen on TV outside the test cell and out of danger.

(Continued on page 11)

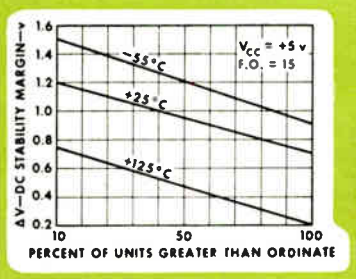
World Radio History

IF YOU'RE DOING SERIOUS WORK WITH * INTEGRATED CIRCUITS *

YOU'LL NEED AT LEAST THIS MUCH INFORMATION TO HELP YOU COMPARE BEFORE YOU'RE COMMITTED.

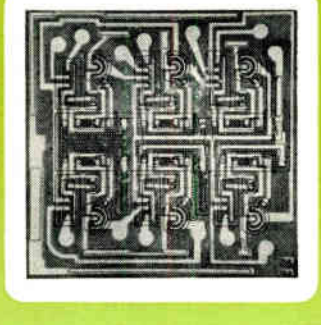
PERFORMANCE

is what you ultimately pay for, and d-c stability margin is one major requirement. To arrive at worst case d-c stability margin **alone**, Siliconix specifies 8 different parameters. Performance is proven through 18 different tests on **each gate** and at three temperatures . . . fifty-four tests in all. Distribution of d-c stability margin for **worst case** input and output loading is shown for all three ambients.



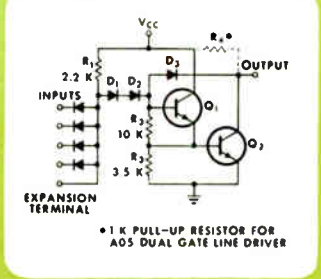
CONSTRUCTION

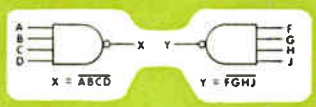
is a significant contributor to performance. For instance, each circuit uses epitaxial transistors and an N+ diffusion to minimize isolation capacitance, to control output resistance, and to improve switching times and yield. For circuit uniformity and cost economy, only one set of deposition and diffusion processes is used for the entire line of circuits.

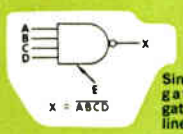


CIRCUITS

are the increasingly popular diode transistor logic (DTL), with the best balance of propagation delay (18 nsec), d-c stability (see curve), and power drain (7 mw) when operated from a single power supply (5v nom). The high-gain circuit removes critical gain-speed tradeoff at temperature extremes on the inverter transistor, providing higher yield while improving performance.



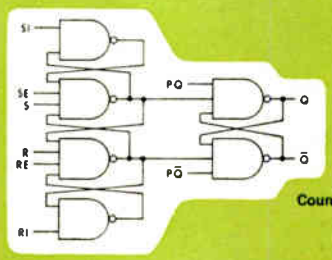




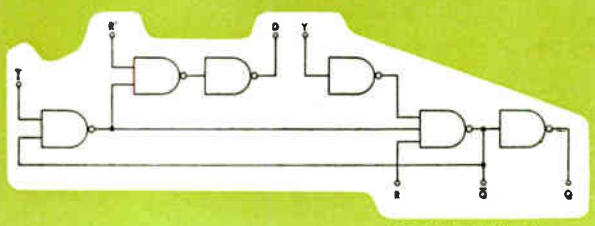
Single and dual NAND gates, power NAND gates, and NAND gate line drivers

AVAILABILITY

means now, from stocking distributors in the U.S. and Europe. The five circuits shown, plus three others, are all available in quantity (up to 1,000) with two weeks delivery. Evaluation kits are airmailed within 4 hours of receipt of order. Specials quoted on request.



Counter, shift register

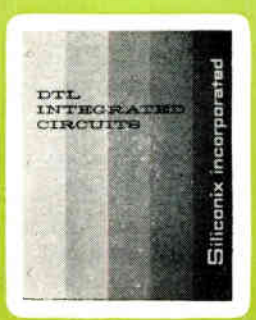


One-shot multivibrator

Fan-in expander

PRICING

is geared to the evaluation order as well as the large one. For instance, if you order just **one** diode array, you get the 1-999 unit price of $7. The counter, shift register is only $29.



BROCHURE

tells all. Write or call collect for detailed specifications on Siliconix integrated circuits. That is, if you're serious.

Siliconix incorporated

1140 West Evelyn Ave. • Sunnyvale 1, California

Telephone 245-1000 • Area Code 408 • TWX 408-737-9948

World Radio History

PROGRESS REPORT

3 Items of Interest on ALSIBASE® Substrates

1. **Standard stock sizes.**
2. **Separate, expedited hand-made sample department.**
3. **A complete new substrate plant.**

Manufactured under one or more of the following Patents: U.S. 2,966,719; U.S. 2,952,877; Also Patent Pending.

Since American Lava Corporation pioneered thin, flat ceramics in 1955, their use has grown. To further encourage the use of AlSiBase substrates, American Lava now offers:

STOCK SIZES. To speed delivery at an attractive price on small quantity requirements, certain widely used sizes are stocked. Other sizes will be added as experience indicates the need.

Unglazed AlSiBase alumina substrates are now stocked in AlSiMag 614 at a thickness of .025" in sizes: ½" x ¾"; 1" x 1"; 1" x 2"; 2" x 2". Unglazed AlSiBase beryllia substrates of AlSiMag 754 are now stocked in 1" x 1". Glazed substrates for precision thin film work are available in all these sizes at a thickness of .030" but require about two weeks additional. Glaze is 743.

HAND-MADE SAMPLES. Stock sizes are helpful but do not always provide the service needed on specials, viz hand-made samples. Picked men and specialized equipment have been combined into a separate department for handling expedited sample orders. Paper work has been simplified to save valuable time in getting sample orders into work. A current inquiry by letter or phone is advisable. At present, highly favorable deliveries are met consistently.

NEW PLANT. In 1955 when the first thin, flat ceramics were pioneered by American Lava Corporation, no one could accurately forecast the growth in demand. Dimensional accuracy, surface characteristics, metallizing compatibility, quantity production techniques and ability to handle complex micro-miniatures have been improved year after year.

New production facilities in a second plant location draw on the wealth of practical experience acquired since 1955 and is unique in its special equipment and experienced skilled personnel.

Provision has been made for further capacity expansion to match needs. This additional production is improving delivery. Our sales engineers will be glad to discuss your requirements.

American Lava Corporation

A SUBSIDIARY OF 3M COMPANY

PHONE 615/265-3411 CHATTANOOGA, TENN. 37405

For service, contact American Lava representatives in Offices of Minnesota Mining and Manufacturing Co. in these cities (see your local telephone directory): Birmingham, Michigan • Boston: Needham Heights, Mass. • Chicago: Bedford Park, Illinois Cleveland, Ohio • Laurens, S. C. • Los Angeles, Calif. • Minneapolis, Minn. • Metropolitan New York: Ridgefield, N. J. Up-State New York: Phelps, New York • Philadelphia, Pennsylvania • Richardson, Texas • South San Francisco, California **All export except Canada:** Minnesota Mining and Manufacturing Co., International Division, 700 Grand Ave., Ridgefield, N. J.

63rd YEAR OF CERAMIC LEADERSHIP

Circle 10 on Inquiry Card

World Radio History

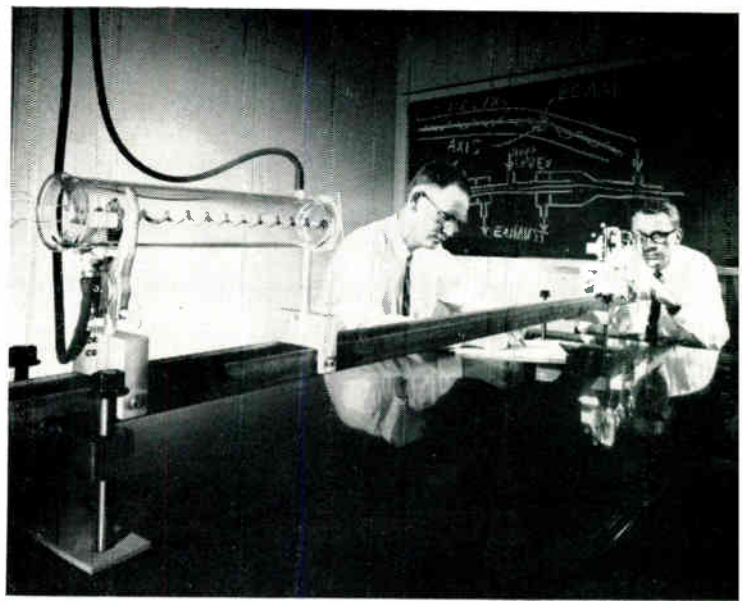
ALL SOLID-STATE LASER using a GaAs injection diode has been developed at RCA's Applied Research Laboratory, Camden, N. J. Researchers predict that use of lasers with thermoelectric cooling (by bismuth telluride semiconductors) could evolve into an operational laser with cryogenics and circuitry enclosed in an evacuated package the size of a soup can. At −130°F laser threshold was 40a. with 200nsec. pulses.

MHD GENERATOR TESTER, has been developed by Westinghouse. The system combines into a single machine a generator and an MHD "motor" arranged in closed loop. White-hot gas plasma of ionized helium and cesium is used. Machine and tests were designed for Air Force Aero-Propulsion Laboratory, Wright-Patterson Air Force Base. Machine measures voltage, plasma temperature, gas velocity, conductivity and other loop characteristics.

SOLAR CELL PANELS made from silicon webbed dendrites have been produced with efficiencies above 10%. Panels have been assembled with 12 large area cells which have a power output of 2.2w under a tungsten light intensity of 100mw/cm²(1 sun). Acceleration and vibration have no effect on the cells but shock and temperature cycling between +80 and −80°C. cause cells to fracture longitudinally. (Dendritic Silicon Solar Cell Panel, AD 429 136, $2.25, OTS, Department of Commerce, Washington, D. C., 20230).

MICROMINIATURE COMPUTER

Providing three-axis aircraft autopilot control, the tiny computer consists of 30 standardized thin-film modules and conventional power supply. Developed by Honeywell Aeronautical (Minneapolis), unit is 65 cu. in., weighs 2.2 lbs. Honeywell evaluation engineer Lloyd Feakes checks out circuitry of successfully tested computer.



LONG-DISTANCE LASER

Gas lenses that show promise for guiding laser beams in pipes for communication over long distances have been developed at the Bell Telephone Laboratories. Dwight Berreman (left) and Andrew Hutson test the experimental helical gas convection lens that uses temperature produced variations in gas refractive index to guide light.

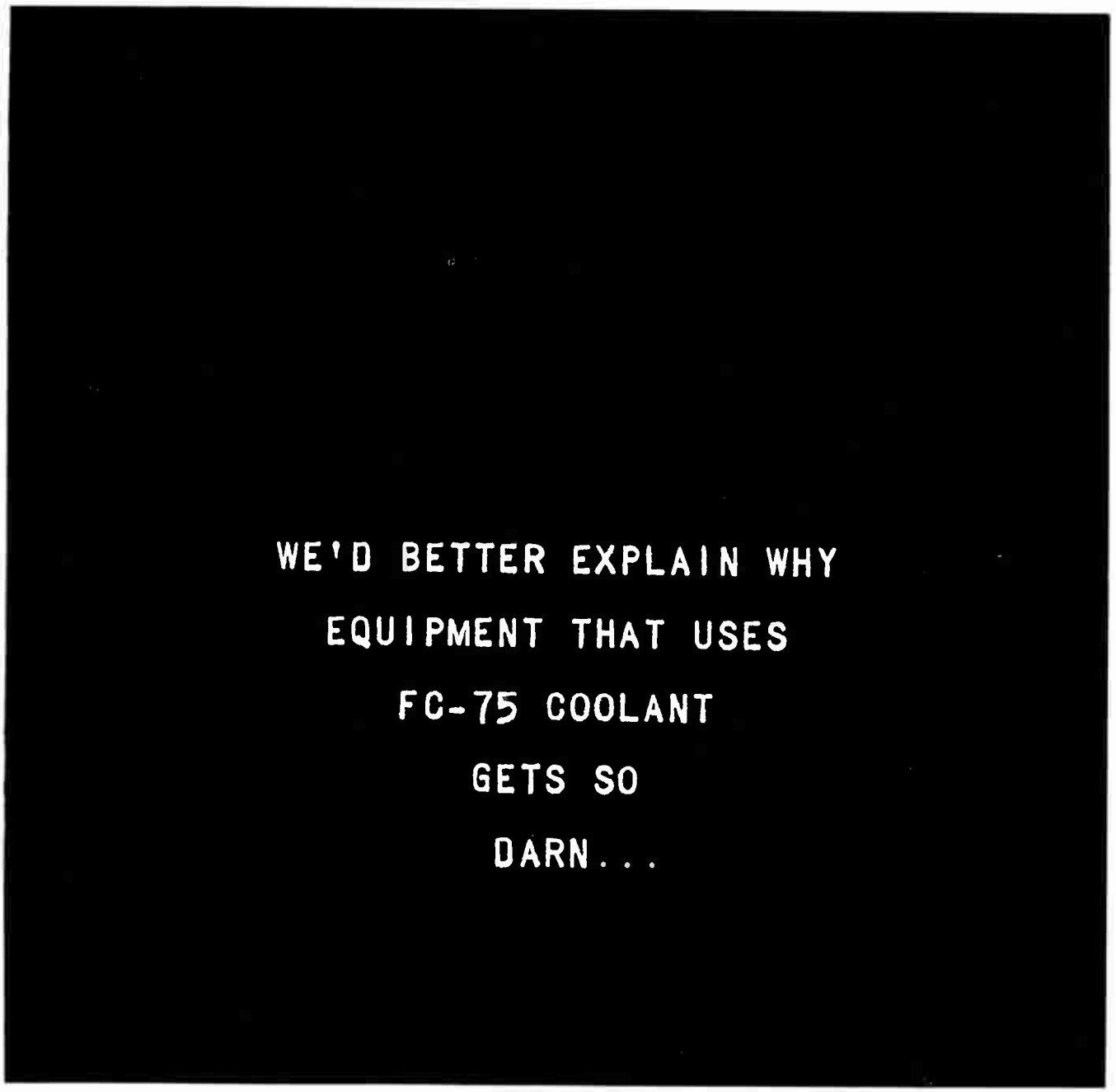
RADAR-TV SYSTEM provides landing information for pilots. The system allows a pilot to identify his aircraft and navigate through a given airspace without ground radar control. He can also confirm presence of other aircraft radar targets in his vicinity to a radar control station. (Remote Airborne Television Display of Ground Radar Coverage Via Taca (RATAC), $1.00, AD 422 426 from OTS, Department of Commerce, Washington D. C., 20230.)

DELETERIOUS EFFECTS on silicon transistors. The Phenomena are described in a report as junction leakage current, junction breakdown voltage, and current gain degradation on n-p-n and p-n-p transistors. The phenomena also applies to insulated gate unipolar field effects transistors, and surface controlled bipolar transistors. Models have been developed to fit surface phenomena, and applications of phenomena are offered. (Deleterious Effects on Silicon Transistors, AD 600 875, $1.25, OTS, Department of Commerce, Washington, D. C., 20230.)

THIN FILM GaAs SOLAR CELLS can reduce cost and weight for solar cell arrays, according to a recent study. Researchers have found techniques for making both p-n junction thin-film cells and surface-barrier thin-film cells with conversion efficiencies of 3% in sunlight. The best fabrication method, the study says, is a GaAs layer grown rapidly by a closed-spaced technique, followed by a short-time zinc diffusion at 750° to 800°C. (Thin Film Gallium Arsenide Study, AD 428 634, $1.75, OTS, Department of Commerce, Washington, D. C., 20230).

(More RADARSCOPE on Page 14)

World Radio History



small

Cooling electronic equipment used to be a big job . . . because of the sheer bulk of the cooling medium. 3M Brand Inert Liquid FC-75 (and its companion FC-43) changed all that. Why? Volatility.

Because of its lower boiling point—100°C, FC-75 removes heat many times faster than non-volatile organic liquid coolants. In fact, per gram of coolant, 30 or 40 times more heat can be removed with FC-75 than with those less volatile media. Same thing goes for FC-43. (Point is, conventional coolants are too "high boiling" to benefit from evaporative cooling, besides losing physical and electrical properties when they boil.)

Results in miniaturization are big! Using FC-75, electronic units have been reduced 4 to 1 in volume, 2 to 1 in weight. No small matter where designers must get more work out of the same space, or do the same job in much less space. Just one example: using FC-75, transformers have been reduced in size by 75%.

Other extras: Both FC-75 and FC-43 are excellent dielectrics—strength in excess of 35 KV, dielectric constant of 1.8, dissipation factor less than 0.0005. No electrical or chemical change in contact with various construction materials. Resist radiation. What big job can these exceptional fluids do for you? For technical details on FC-75 and FC-43, write Chemical Division, Dept. KCQ-94, 3M Company, St. Paul 19, Minnesota.

Chemical Division 3M COMPANY

World Radio History

Want to be an Executive?

Management is actively looking for engineers who have the desire and ability to become administrators

by
James M. Jenks

In a sense, this is the golden age for engineers. Once buried in corporate obscurity, many of them have emerged today as likely heirs apparent to the big jobs — and the big rewards — of business and industry. One impressive indication of this growth is that money spent in research and development over the past fifteen years has increased six-fold.

Despite this stepped-up activity, however, the once disorganized scramble for engineers seems to have ended . . . at least temporarily. And perhaps it's a good thing. Actually, the more perceptive engineers had always realized that unusually high starting salaries were often illusory. The gap between money being offered beginners and the incomes of experienced men was narrowing rapidly. Further, more and more thinking technical men concluded that even top engineering salaries are low when compared with the remuneration of highly placed general executives.

A Plan to Help the Engineer Succeed

Happily, there is a route to increased incomes that is satisfying to both engineer and company alike. This route leads into *management*. It is no easy road but the rewards are great for those willing and able to follow it.

In the vast, complicated world of business the engineer has much to learn. As a manager his duties will bring him into contact with accountants and buyers, advertising men and salesmen, lawyers and other executives. A strange new set of circumstances confronts him. He must gain confidences and be understanding, learn and instruct, be sympathetic, paternal or commanding as conditions require . . . and all in the midst of a business organization about which his knowledge is limited.

Actually, it comes down to this: To succeed as a business executive, the engineer must learn the art of making decisions quickly and accurately. And this ability is, of course, directly dependent upon knowledge. The "principles" of business—while not as scientific and inexorable as those of engineering—are no less important . . . no less essential to efficient procedure.

For nearly fifty years, the Alexander Hamilton Institute has specialized in bringing this knowledge to mature men—at home in their spare time.

Free . . . "Forging Ahead in Business"

We do not claim that you must have the Alexander Hamilton Course in order to succeed in business. But we do say that *you cannot succeed without what is in the Course!*

All the Institute does is offer you a convenient and time-saving means of bringing this knowledge to you in your spare time; and in a form that has *proved* to be practical and effective.

So that you may judge for yourself whether or not you think the Institute can help you, we have published an informative 48-page book titled "Forging Ahead in Business."

We believe that this little book will help any man get down to bedrock in his thinking; however, there's no cost or obligation for it because—frankly—we've never been able to put a price on it that would reflect its true value. Some men have found a fortune in its pages.

If you would like a complimentary copy of "Forging Ahead in Business", simply sign and return the coupon below. It will be mailed to you promptly.

ALEXANDER HAMILTON INSTITUTE
Dept. 554, 235 East 42nd Street, N.Y. 17, N.Y.
In Canada: 57 Bloor St., W., Toronto, Ontario.

Please mail me, without cost, a copy of the 48-page book—
"FORGING AHEAD IN BUSINESS"

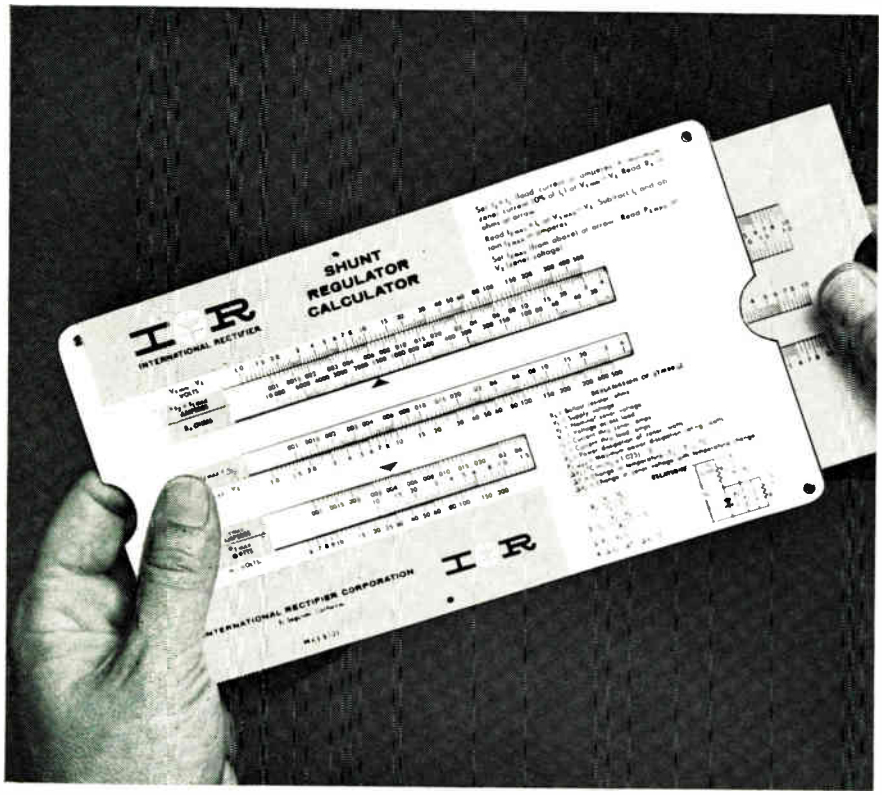
Name_____
Firm Name_____
Business Address_____
Position_____
Home Address_____

27B

World Radio History

INTERNATIONAL RECTIFIER ZENER CALCULATOR

Pinpoint Your Zener Diode Needs in Seconds



With just two quick slip-stick calculations, this new compact International Rectifier Zener Calculator gives you Zener diode specifications in terms of easy reference JEDEC numbers and case styles. You may obtain this circuit design aid without charge upon written request on your company letterhead to International Rectifier Corporation, 233 Kansas Street, El Segundo, California.

When you specify International Rectifier Zeners you have this unique assurance of performance... a demonstrated in-use reliability index of 99.988%. To meet a wide range of requirements, International Rectifier offers a selection of over 640 types. International Rectifier's sales offices and distribution network throughout the United States provide immediate customer service.

INTERNATIONAL RECTIFIER

INTERNATIONAL RECTIFIER CORP., EL SEGUNDO, CALIF., PHONE OR 8-6281 • CABLE RECTUSA • REGIONAL OFFICES IN NEW YORK CITY, CH 4-0748 • FORT LEE, N. J., WI 7-3311 • SYRACUSE, N. Y., HE 7-8495 • CAMBRIDGE, MASS., UN 4-6520 • ARDMORE, PA., MI 9-3667, GR 3-3932 • SILVER SPRING, MD., JU 9-3305 • MIAMI, FLA., 445-5201 • CHICAGO, ILL., OR 6-4090 • CLEVELAND, OHIO, 734-4100 • DAYTON, OHIO, 223-7691 • HUNTINGTON WOODS, MICH., LI 8-1144 • ST. LOUIS, MO., TE 8-6333 • MINNEAPOLIS, MINN., 920-1200 • DALLAS, TEX., LA 1-0110 • LOS ANGELES, CALIF., OR 8-6281 • IN CANADA: TORONTO, ONT., PL 9-7581 • MONTREAL, QUE., 861-6552

RADARSCOPE

DATA RETRIEVAL SYSTEM, considered the world's largest medical information operation, is in use at the National Library of Medicine, Bethesda, Md. Developed by Honeywell, the system (MEDLARS — Medical Literature Analysis and Retrieval System) exploits a single data input to produce multiple printed outputs having at least five times as much data as originally put in. MEDLARS is a $3-million system built around a large-scale Honeywell 800 computer.

STEER-DIVE CONTROLS, considered so simple that an inexperienced operator can guide a craft on first watch, is being installed in the Navy's new fleet of missile submarines. "Conalog," designed for Navy Bureau of Ships by Norden Division of United Aircraft, provides automatic depth and course control. It includes a new concept of data presentation based on the contact analog principle. System integrates all data needed on a 19-inch CRT. Display simulates view operator might see through a window.

LIGHT-MEASURING TUBES, developed by a division of IT&T Corp., were used in recent experiments that detected water vapor in Venus' atmosphere, lending support to possibility of life on the green planet. An FW 118 "star-tracker" tube pointed a balloon-borne automatic telescope at Venus at about 87,500 feet up, accuracy was one second of arc for two hours of observation in broad daylight. Another tube, a low-noise high-sensitivity IR radiation detector was used to "see" how water vapor absorbed IR wavelengths in sunlight reflected by Venus' clouds. Experiments were conducted jointly by Johns Hopkins University and Air Force Cambridge Laboratories.

World Radio History

COMING EVENTS

September

Sept. 17-18: 12th Annual Joint Eng. Mgt. Conf., IEEE, AICE, AIChE, et al; Pick-Carter Hotel, Cleveland, Ohio.
Sept. 22-24: PTG on Antennas & Propagation Int'l Symp., PTG-AP IEEE; Int'l Airport, L.I., N.Y.
Sept. 24-26: 14th Annual Symp. on Broadcasting, PTG-B IEEE; Washington, D.C.
Sept. 25-26: 12th Annual Conf. on Communications, IEEE; Hotel Roosevelt, Cedar Rapids, Iowa.
Sept. 25-26: 3rd Canadian Symp. on Communications, Montreal Sec. & Region 7 IEEE; Queen Elizabeth Hotel, Montreal, Canada.
Sept. 27-Oct. 1: Nat'l Power Conf., IEEE, ASME; Mayo Hotel, Tulsa, Okla.
Sept. 27-Oct. 2: 96th Tech. Conf., Soc. of Motion Picture & TV Engineers; Commodore Hotel, New York, N.Y.
Sept. 28-30: 2nd Annual Conf. on Circuit and System Theory, IEEE, Univ. of Ill.; Univ. of Ill., Monticello, Ill.

October

Oct. 5-7: 10th Annual Communications Symp., PTG-CS IEEE; Utica, N.Y.
Oct. 6-9: Int'l Space Electronic Symp., PTG IEEE; Dunes Hotel, Las Vegas, Nev.

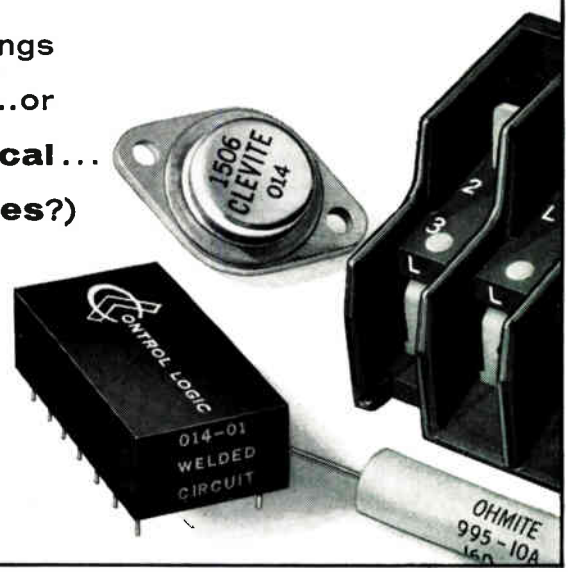
'64-'65 HIGHLIGHTS

Nat'l Electronics Conf., Oct. 19-21, IEEE, et al; McCormick Place, Chicago, Ill.
NEREM, Northeast Research & Eng. Mtg., Nov. 4-6, IEEE; Boston, Mass.
IEEE Int'l Conv., Mar. 22-25; Coliseum, New York Hilton, New York, N. Y.
WESCON, Western Electronic Show & Conv., Aug. 24-27, IEEE, WEMA; Cow Palace, San Francisco, Calif.

Oct. 11-14: 1964 Fall URSI-IEEE Meeting; Univ. of Ill., Urban, Ill.
Oct. 12-14: Conf. on Electrical Insulation, NAS, NRC; Union Carbide Corp., Cleveland, Ohio.
Oct. 12-15: 19th Annual Int'l Instrument-Automation Conf. & Exh., ISA; New York Coliseum, New York, N. Y.
Oct. 14-16: 1964 Sonics & Ultrasonics Symp., PTG-SU IEEE; Miramar Hotel, Santa Monica, Calif.
Oct. 15-16: Systems Science Conf., SC-TC, Univ. of Pa.; Univ. of Pa., Phila., Pa.
Oct. 15-17: Symp. on Aerospace Frontiers in New Mexico, ASME; Univ. of New Mexico, Albuquerque, N. M.
Oct. 17-18: ASM Metals/Materials Congress and Exp., ASM; Bellevue-Stratford Hotel, Phila., Pa.
Oct. 19-21: Nat'l Electronics Conf., IEEE, et al; McCormick Pl., Chicago, Ill.

Need to say a lot in a **little space?**

(or make markings more **durable**...or more **economical**... or at **higher rates?**)



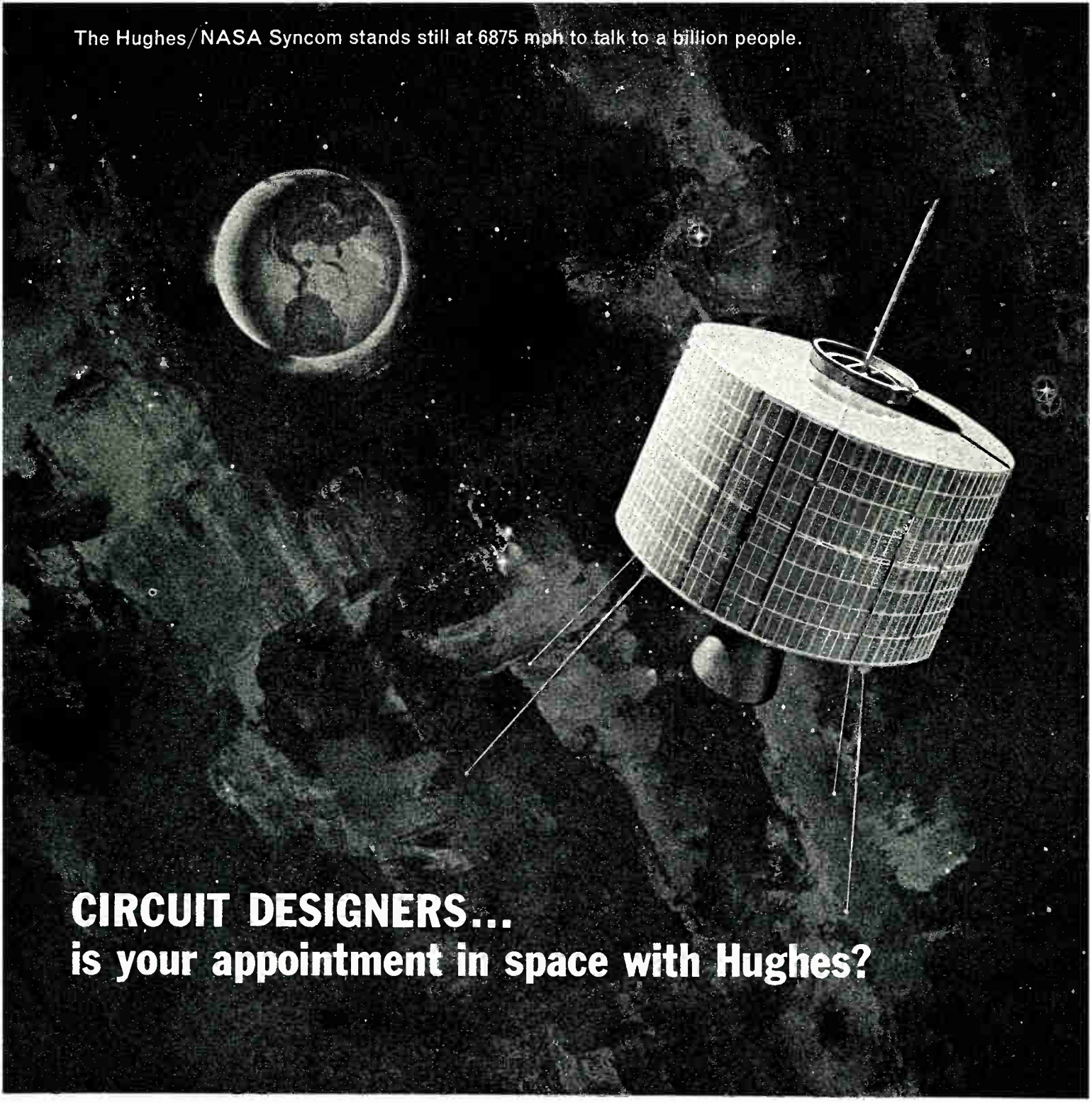
We can show you how

We can show you how to identify products so they will resist extreme amounts of handling, abrasion, many solvents and other atmospheric conditions . . . or how to sequentially number and identify components with savings of more than $50 per 1000 . . . or how to print trademark, type number, value and date code on 90 units a minute . . . or how to produce an imprint that remains readable after 1000 hours at 200°C. . . . or get 10 digits and 2 letters in a micro-circuit area of 0.090″ — or 21 characters on a TO-5 case with interchangeable type number and date code . . . or save 75 cents of every dollar you now spend on buying, applying, inventorying and discarding obsolete preprinted labels.

The answers are in proven Markem machines, type and specialty inks, which daily produce better product or package identification by reducing costs, smoothing production control and increasing customer acceptance. And while Markem machines, type and inks are helping to produce better products through more complete and lasting identification, they frequently pay for themselves in the savings they make possible. Tell us what *you* make, what it must say, and for how long: we'll give you a specific recommendation and cost estimate right away. Write Electrical Division, Markem Machine Co., 392 Congress St., Keene, New Hampshire 03431.

MARKEM

World Radio History



CIRCUIT DESIGNERS...
is your appointment in space with Hughes?

Today, Hughes is one of the nation's most active aerospace/electronics firms. Projects include: F-111B PHOENIX Guided Missile System, TOW Anti-Tank Missile, SURVEYOR Lunar Spacecraft, SYNCOM, VATE, ARPAT, POLARIS, Hard Point Defense and others.

This vigor will assist the qualified engineers and scientists towards more and better opportunities for both professional and personal growth.

Many immediate openings exist. The engineers selected for these positions will be assigned to the following design tasks: the development of high power airborne radar transmitters, the design of which involves use of the most advanced components; the design of low noise radar receivers using parametric amplifiers; solid state masers and other advanced microwave components; radar data processing circuit design, including range and speed trackers, crystal filter circuitry and a variety of display circuits; high efficiency power supplies for airborne and space electronic systems; telemetering and command circuits for space vehicles, timing, control and display circuits for the Hughes COLIDAR (Coherent Light Detection and Ranging).

If you are interested and believe that you can contribute, make your appointment today.

For immediate consideration, please airmail your resume to:

Mr. Robert A. Martin
Head of Employment
Hughes Aerospace Divisions
11940 W. Jefferson Blvd.
Culver City 43, California

Creating a new world with electronics

HUGHES

HUGHES AIRCRAFT COMPANY
AEROSPACE DIVISIONS
An equal opportunity employer.
U. S. CITIZENSHIP REQUIRED

Circle 12 on Inquiry Card →

World Radio History

motor size reduced one-third without sacrifice in performance

■ The illustration above typifies the size reduction in motor design that the new Allen-Bradley MO5C permanent magnet material makes possible—*with no loss in motor performance.*

Type MO5C is an oriented ceramic permanent magnet material—yet it can be produced in shapes previously limited to unoriented materials. It possesses a high energy product—2.6 times that of unoriented materials—plus a high coercive force. Thus, the Type MO5C is practical for motors from fractional to multiple horsepower ratings, covering a wide range of speeds.

In addition, the high coercive force of MO5C material makes much shorter magnet lengths possible than with metallic magnets. Leakage flux is reduced . . . magnetic circuit efficiency is increased.

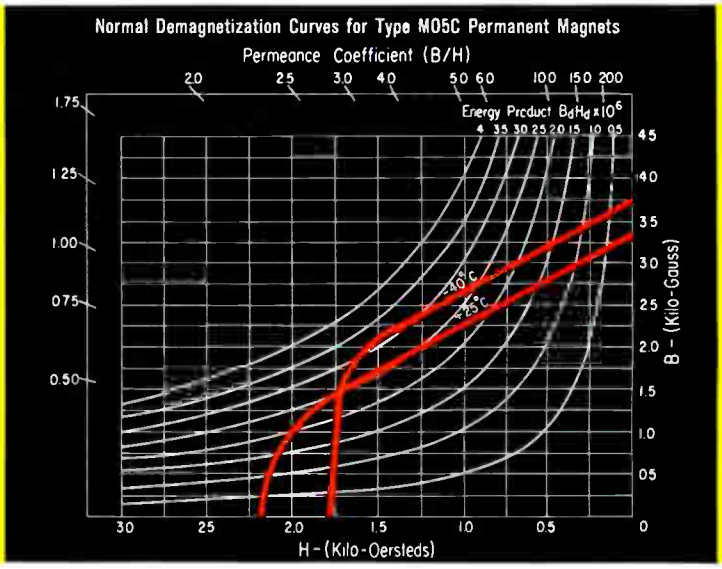
Allen-Bradley MO5C permanent magnets enable motor field assemblies to be simplified, which may result in cost savings over a construction using a metallic magnet or wound fields.

It will pay you to investigate the unusual economic and design advantages of this new MO5C oriented magnet material. For more complete details, please write for Technical Bulletin B5650A: Allen-Bradley Co., 222 W. Greenfield Avenue, Milwaukee, Wisconsin 53204.

In Canada: Allen-Bradley Canada Ltd., Galt, Ontario.

CHARACTERISTICS—Important characteristics of MO5C are tabulated below at a temperature of 25°C.

Residual Induction (B_r) gauss	3300
Coercive Force (H_c) oersteds	2200
Intrinsic Coercive Force (H_{ci}) oersteds	2300
Peak Energy Product (B_dH_d) gauss·oersteds	2.6×10^6
Reversible Permeability	1.09
Curie Temperature Deg. C	450
Temperature Coefficient of Flux Density at B_r, %/°C	−0.19
Temperature Coefficient of Intrinsic Coercive Force, %/°C	+0.25
Specific Gravity	4.85
Weight Per Cu. In. Lbs.	0.175
Resistivity Ohm/Cm³	10^9
Coefficient of Thermal Expansion per Deg. C Parallel to Orientation	14.5×10^{-6}
Perpendicular to Orientation	11.0×10^{-6}

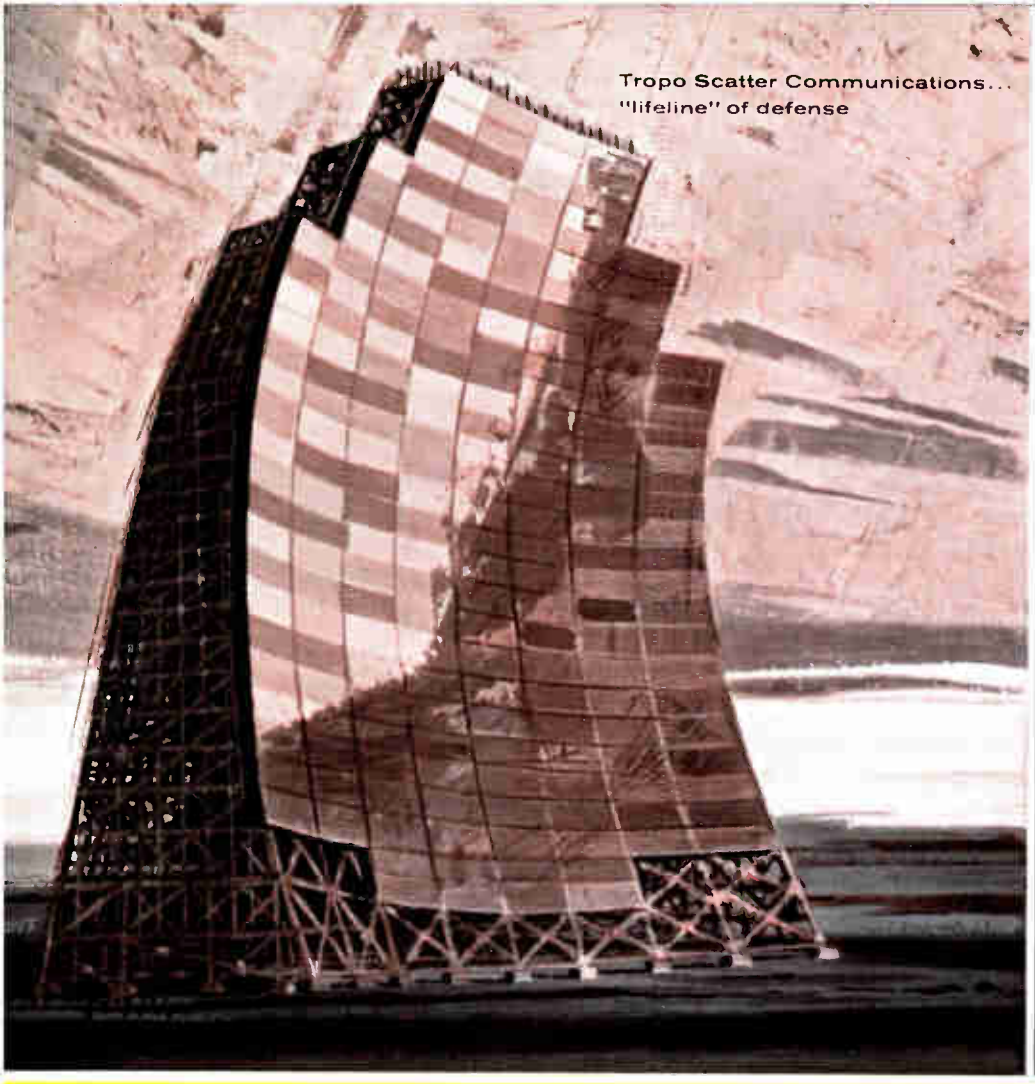


ALLEN-BRADLEY

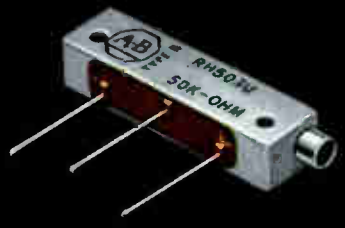
QUALITY ELECTRONIC COMPONENTS

36-08-4E

World Radio History



A-B HOT MOLDED RESISTORS are available in 1/10, ⅛, ¼, ½, 1, and 2-watt ratings, and in all standard EIA and MIL-R-11 resistance values and tolerances, plus values above and below standard limits.



TYPE R ADJUSTABLE FIXED RESISTORS, rated ¼ watt at 70°C, available in total resistance values from 100 ohms to 2.5 megohms.

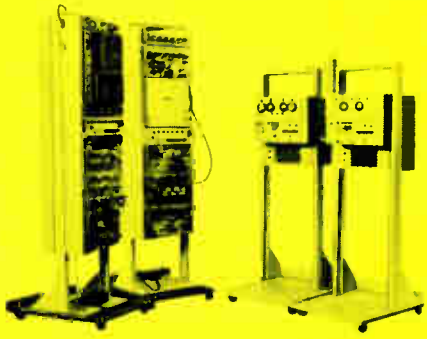
Radio Engineering Laboratories Tropo Scatter Radio Terminals use Allen-Bradley Hot Molded Resistors because there are none more reliable!

Radio Engineering Laboratories, Inc. must employ the most reliable components available to achieve the 99.9% reliability required—only 8.7 actual hours outage in a total year round-the-clock operation—in systems under the direction of the Defense Communications Agency. For this reason, extensive use is made of Allen-Bradley fixed and adjustable fixed resistors in REL'S 2600 Series Tropospheric Scatter Radio Terminals.

The Allen-Bradley hot molding process—invented and used exclusively by A-B—produces such precise uniformity from resistor to resistor, from one million to the next, that long term resistor performance can be accurately predicted. Their stable characteristics and conservative ratings have made Allen-Bradley hot molded resistors preferred wherever the ultimate in performance is demanded.

Allen-Bradley's Type R adjustable fixed resistors—made by the same exclusive hot molding process—provide smooth and exact adjustment. They're ruggedly built and will remain stable under extremes of shock and vibration.

For more details on the complete line of Allen-Bradley quality electronic components, please write for Publication 6024: Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee, Wis. 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ontario.



This illustrates reduction in volume achieved in R E L'S 2600 equipment. Racks at left show exciter and receiver using tube construction. At right are the equivalent solid state gear. Transistorized circuitry and the use of Allen-Bradley Type CB ¼-watt resistors contributed to this size reduction. A-B pioneered and introduced the ¼-watt resistor.

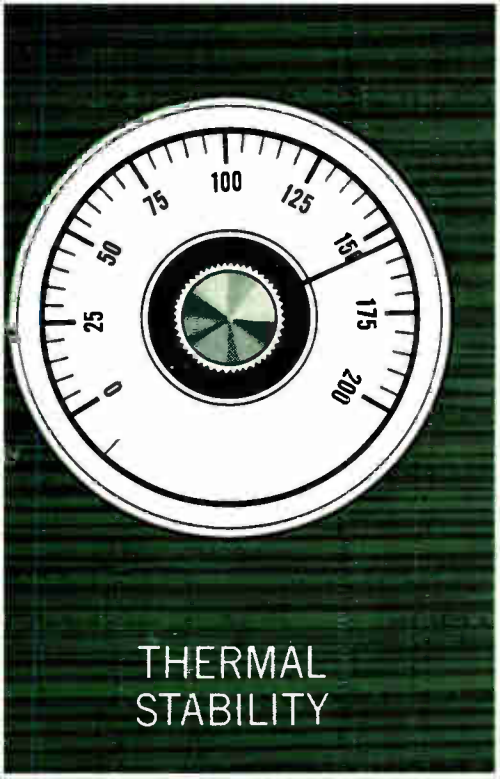
35.08 4E

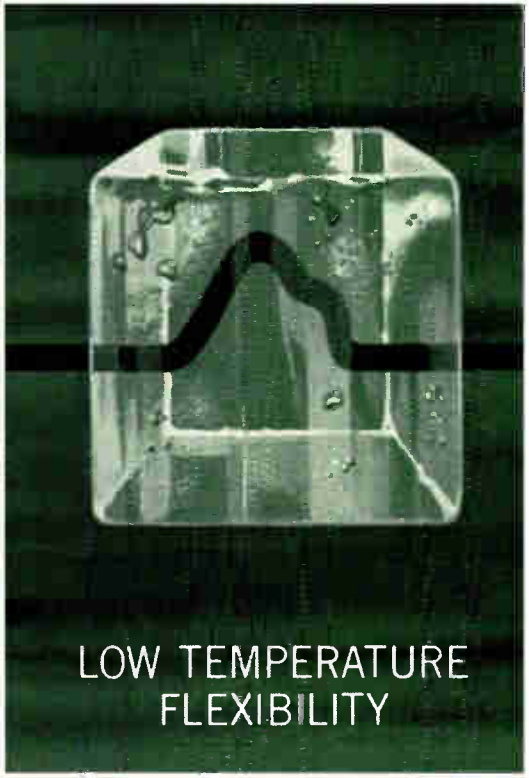
A-B QUALITY

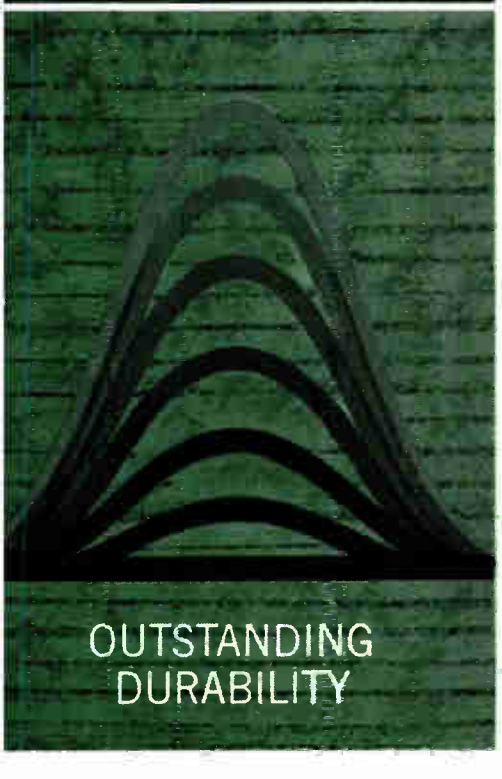
ALLEN-BRADLEY

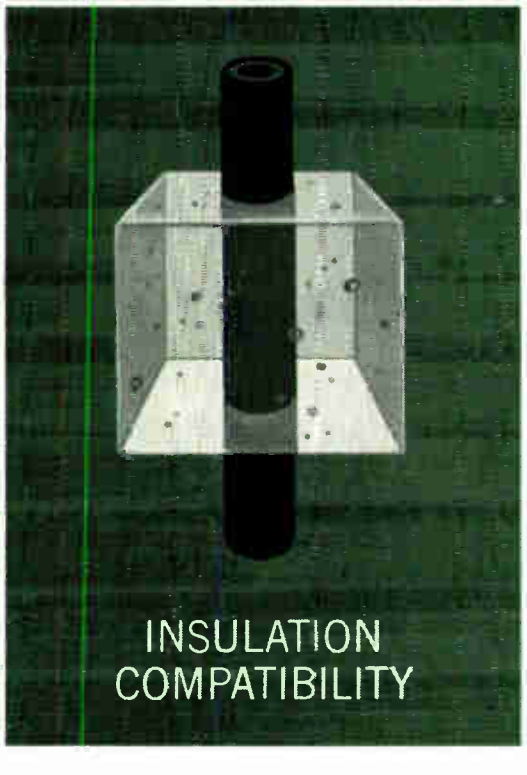
QUALITY ELECTRONIC COMPONENTS

World Radio History









New "Irvington" Brand Class F Tubing assures reliability under all conditions

Now, a 5000 volt tubing that maintains 5000 volts throughout its operational life! New "Irvington" Brand Epoxy Coated Glass Tubing No. 450 is a 5000 volt tubing at room temperature . . . remains at the 5000 volt level at 155°C. It even performs at higher temperatures for short periods (1000 hours at 180°C. for example). How about moisture? No problem. New No. 450 retains 5000 volts at 96% RH. Cold? Stays flexible at −60°C. And there's more good news. No. 450 is remarkably resistant to abrasion and solvents. Provides perfect compatibility with epoxy resins, varnishes and magnet wire enamels to assure void-free seals.

What does it all mean? Now you no longer have to put up with materials that are rated in a given temperature range but lose 50-75% of their dielectric strength when the temperature rises. You no longer have to over-compensate by jumping to expensive Class H materials to get Class F performance.

Get all the facts on how "Irvington" Tubing No. 450 can add new reliability to your Class F motors, transformers, epoxy encapsulated units or aerospace equipment. See your 3M "IQ" Man or write: 3M Co., Irvington/Mico Division, St. Paul 19, Minn., Dept. ECO-94.

INSULATIONS? SEE YOUR 3M IQ MAN*

*"IQ" means Insulation Qualified. Your 3M Man is trained and qualified to advise and assist with electrical insulation problems.

3M Irvington/Mico Division
MINNESOTA MINING & MANUFACTURING CO.

"IRVINGTON" IS A REGISTERED TRADEMARK OF 3M CO., ST. PAUL 19, MINN.

TAPES • RESINS • TUBING • VARNISHES • COATED FABRICS • LAMINATES • MICA PRODUCTS

← Circle 12 on Inquiry Card

World Radio History

Circle 13 on Inquiry Card

HIGHER PROFITS FOR INDUSTRY—Defense industry profits are not high enough, Secretary McNamara has observed several times. He thinks one way to raise profits is to do away completely with cost-plus type of contracts and get industry to rely more on higher-risk but more income fixed-price or incentive contracts. Congressional committees are hearing varied testimony. Cost-plus contracts may pass away sooner than expected.

COMSAT INVESTORS — FCC Commissioner Rosel H. Hyde cautioned investors in Communications Satellite Corp. "not to overlook or treat lightly many problems yet facing ComSat." He cited the selection of satellite design under which provisions of the Satellite Act must be approved by the FCC. He also reminded investors that we must resolve some problems in working agreements with other nations.

COMSAT NATIONS AGREE—U. S. and 13 nations signed two agreements Aug. 19 concerning broad policy of COMSAT system operation, and details of commercial, financial, and technical procedure. Of estimated $200 million tab for COMSAT, U. S. will pay lion's share of 61%. European nations will put up about 10%, and Canada, Australia, Japan and the Vatican the remainder. Russia said, "nyet!"

MORE AGENCIES COMING—Destinies of electronic firms may be affected by Congressional action on proposed agencies. A National Oceanographic Council is sought to help coordinate work being done by 22 separate federal offices. A National Economic Conversion Commission would be responsible for a blueprint to expedite conversion of defense facilities. A National Commission on Automation would investigate effects of technology and change.

ANOTHER STEP FOR LASERS—A laser advisory group has been established by General Frank Besson's Army Materiel Command. It will coordinate R&D in the field and supervise Army input to the DOD Special Group on Optical Lasers.

ENGINEER SURPLUS-SHORTAGE? — Secretary of Defense McNamara caused eyebrows to arch when he said that shift from cost-plus to fixed-fee or incentive contracts would release large numbers of engineers, thus solving the "shortage." Some major contractors have released engineers in large numbers and they haven't found new jobs. The Secretary's remarks were open to question. He referred to a report on a very severe market shortage in engineers that indicated the market was much less tight now than it had been.

DEFENSE BRIEFINGS — Contractors fidgety about the future can get a good look at Pentagon planning at a series of unclassified briefings by Defense officials. Briefings are set for New York City, Sept. 17-18; Chicago, Sept. 29-30; Dallas, Oct. 13-14; and Los Angeles, Oct. 28-29. Eight others will be slated for next spring. National Security Industrial Association is sponsoring the seminars. They will be conducted by top Pentagon brass covering various government, defense, and military subjects.

HOW TO CONVERT, EFFECTIVELY — U. S. agencies are pouring out free advice to firms on how to convert in a hurry. The facts of life are that they can no longer hide from the facts. Defense spending cuts are here, and probably to stay. DOD spending had been about 10% of gross national product; in fiscal 1963 it dipped to 9.3%, and the trend is downward.

UNION CONVERSION AID PLAN — Senate committee is pondering labor union plan calling for aid to small firms converting to civilian output. Aid would include such devices as low-interest U. S. loans, tax benefits, and even outright gifts of U. S. cash. Voting of any such measures into law is not assured. Thought is spreading on Capitol Hill that small defense firms will need material aid.

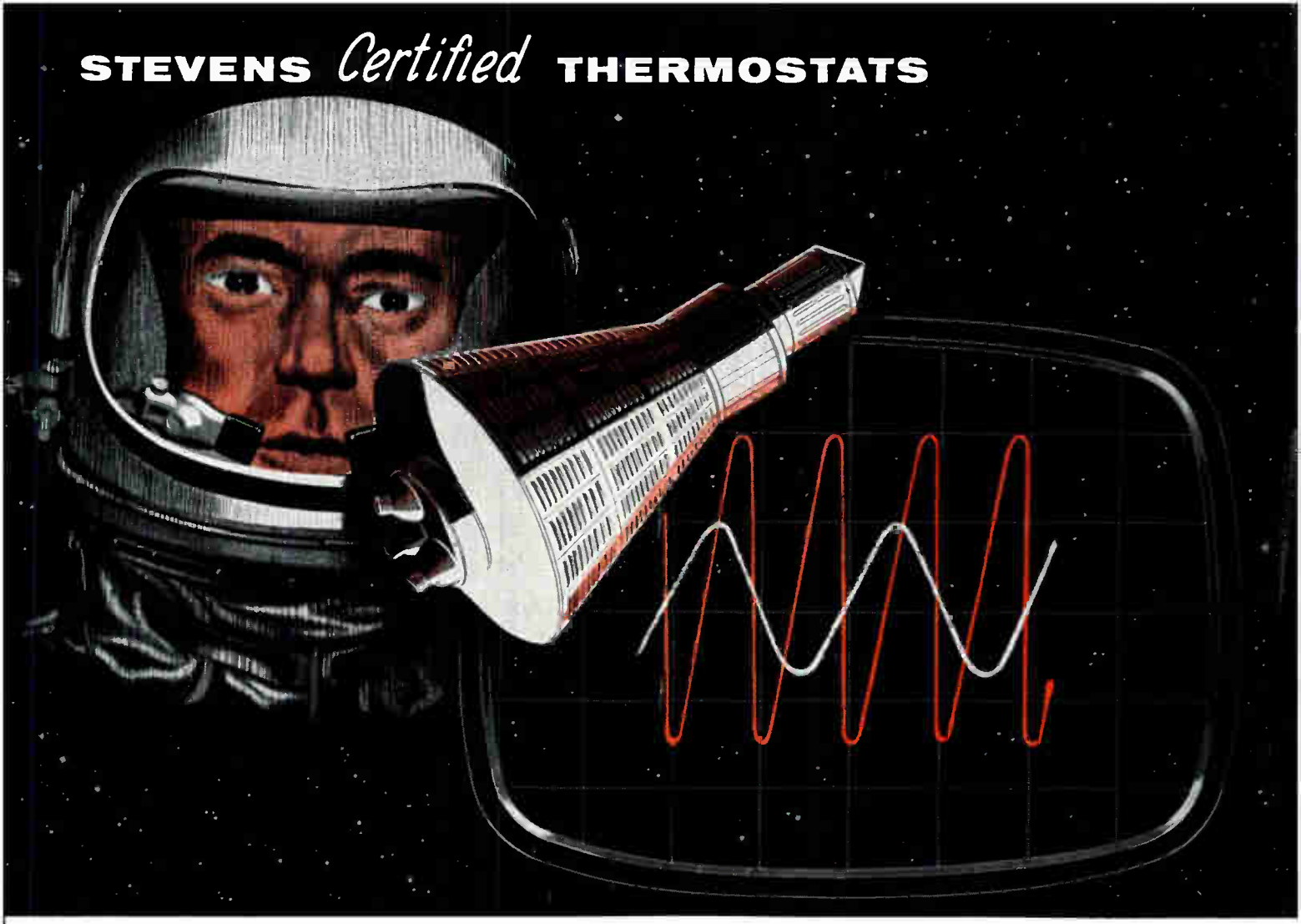
PMC TESTS ENDING—Army's Pulse Code Modulation (PMC) is nearing end of its testing phase. The new form of communication converts speech, facsimile, tones, and other signals to numerical form, and sends data via six-bit code. Object is to ease overcrowded military channels.

MORE DATA FOR ENGINEERS — NASA has launched its Selective Dissemination of Information (SDI) program to make reports on new developments continually available. Engineers submit "interest profiles" in terms of data needed. Profile is matched, by computer, with profiles of new technical reports. NASA sends abstracts, and then engineers request reports from nearest technical libraries.

CONTRACTOR COSTS EYED — Flying a load of crabs cross country for a crab fete is not considered cricket if defense money pays for it. In what could develop into a "get tough" attitude, congressional committees, Department of Defense, and U. S. General Accounting Office are taking another look at expenses contractors have charged to Uncle Sam. Costs traceable to "employee recreation" and "company morale" are somewhat open to question in this newest "what's-our-money-buying" barrage from Capitol Hill.

World Radio History

STEVENS *Certified* THERMOSTATS



*for electronic and aerospace applications**

If Space is your dimension, take the measure of Stevens *Certified* Thermostats. For in hostile aerospace environments, you can't take a chance on Reliability.

Since Stevens makes the broadest line of bimetal thermostats in the industry, you can get all the special features to fit your special requirements *exactly* right from a *proven*, standard production-line Stemco thermostat, or from a minor modification thereof. This also gets your product off the ground faster . . . by cutting lead time . . . by slashing engineering and development costs.

If reliability, weight, smaller size and cost are considerations, there's only the Stevens *Certified* Thermostat line to consider. Start the countdown sooner by putting us in your supplier orbit.

**Above Stemco Thermostats are designed and manufactured to meet most requirements of applicable MIL specifications.*

Type MX Hermetic

Snap-acting to open on temperature rise only. Highly responsive copper housing. Standard tolerance ±3°F with 2 to 6°F differentials; 1 to 4°F differentials on special order. Temperature 10° to 260°F. Various terminals and mounting brackets. See Bulletin 6100.

Type AX Hermetic

Similar to Type MX but to close on temperature rise. Wide selection of terminals and mounting provisions, highly responsive brass housing. 2° to 6°F differential. Bulletin 3200.

Type C Hermetic

Field-adjustable, positive-acting. Electrically independent bimetal strip type for operation from −10° to 300°F. Also supplied as double thermostat 'alarm' type. Turret terminals or wire leads. For ratings, etc., Bulletin 5000.

Type A Hermetic

Electrically independent bimetal disc and high-response brass case for quick, snap-action control from −10° to 300°F. Various enclosures, terminal arrangements and mounting provisions, including brackets. Bulletin 3000.

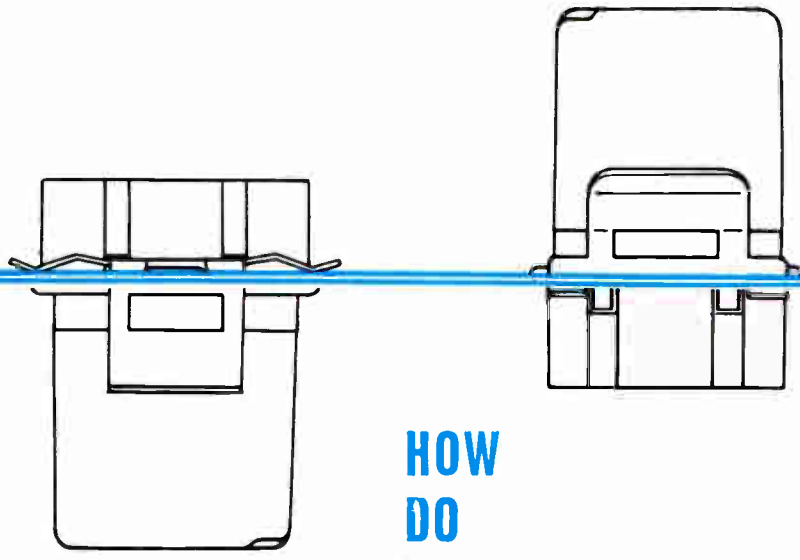
A-7192A

STEVENS *manufacturing company, inc.*
P.O. Box 1007 • Mansfield, Ohio

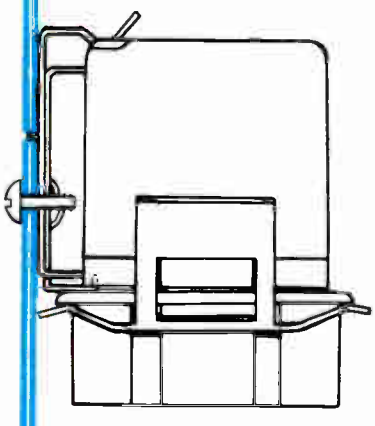
Circle 14 on Inquiry Card

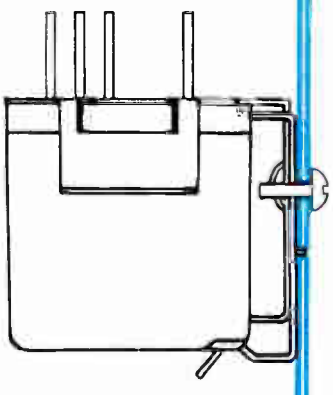
® STEMCO **THERMOSTATS**

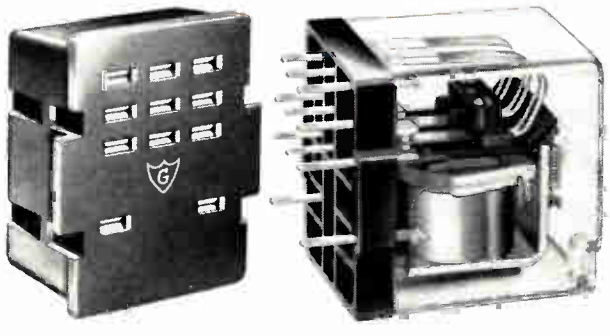
World Radio History



HOW DO YOU WANT TO MOUNT THIS NEW RELAY?







Guardian's new series 1220 relay mounts 4 different ways

Try to beat this new Guardian 1220 AC—1225 DC relay for mounting versatility. Mount it *through* the chassis for easy front side assembly or disassembly. That's one way. Mount it through the chassis permanently with a one-piece socket mounting clip. That's two. Number three? "Snap-bracket" mount it above the chassis using the socket housing and one-piece mounting clip as a cable connector. Four? Snap-bracket mount it above the chassis for quick connects or soldering as supplied with the relay.

But mounting versatility is not the only feature that's new. With the terminal panel as the male plug, it eliminates the radio-type plug, extra wiring and sub-assembly between relay and plug. No mounting screws either. And a new Uni-Guard switch eliminates internal solder connections.

All this is yours in the new 1220 series relay for less than $2.00 each in quantity. New Bulletin 1220-2 tells all. Write for your copy.

GUARDIAN® ELECTRIC

Guardian Electric Manufacturing Company • 1550 W. Carroll Avenue, Dept. EI 49, Chicago, Ill. 60607

World Radio History

118 ELECTRONIC FIRMS FAILED DURING YEAR

More electronic firms hit bottom during the 12 months ended March 31 than in any earlier period, according to a report of the Credit Committee of the Electronic Industries Association.

Some 118 companies — manufacturers and distributors—felt financial embarrassments totaling $49,577,000. In the previous year, 88 firms failed with liabilities of $44,427,000. The year before that only 56 firms ended with $27,879,000 in liabilities.

Among 100 manufacturers who began reorganization or liquidation in 1963-64 were these product categories: components, 32 firms; instruments, 14; R&D, 9; entertainment products, 12; systems, 8; EDP equipment, 3.

Searching for some reasons, the committee observed that "a decade of expansion came to an abrupt halt. Readjustment of government procurement programs, competition from abroad, for some products, and sharply falling prices created problems that could not be solved in an orderly manner."

The committee offered other reasons: working capital for marginal firms was hard to get, public financing was offered only to firms with strong earnings records, and profit margins often declined or were replaced by losses. There was noticeable rise in delinquent payments, and debt became unsupportable as many firms felt forced to rely on trade suppliers.

The merger pace did not slow down, though buyers did become more choosey. Acquisition by a larger-stronger firm was not close at hand as a shelter for undercapitalized business as it had been.

LOW-COST TRANSISTORS SPUR SOLID-STATE CIRCUIT USE

Lower unit cost of transistors is speeding up the use of solid-state circuits in consumer electronic products.

Increasing numbers of 1964-1965 models of consumer radios, high fidelity sound systems, and television sets are transistorized. Motorola uses solid-state amplifiers on 23 out of 34 of its new phonograph models.

An 11-inch television set, priced less than $150 to compete with vacuum tube sets, has been introduced by Emerson Radio. Texas Instruments makes the set's 22 germanium and silicon transistors, 13 silicon diodes and rectifiers, and 1 silicon gate-controlled switch.

Emerson's board chairman Benjamin Abrams predicted, "By 1966 one-third of all television sets produced in America will be transistorized. By 1969 the television industry will be dominated by solid-state products.

U. S. FIRMS DISPLAY COMPUTER WARES IN WEST GERMANY

U. S. computer salesmen and West German buyers made quick connections during the Computer and Computer Systems Show at the U. S. Trade Center in Frankfurt. Control Data 606 magnetic tape handler is test-run by Peter Novak (back to camera), sales engineer for Control Data. Among firms showing were IBM, Honeywell.

FOREIGN TRADE SUGGESTED AS MEANS TO DIVERSIFY

Jay Rodney Reese, vice president of world marketing, Texas Instruments, Inc., recommended foreign trade as a means of diversifying activities of defense electronic companies, before an American Management Association briefing on "Planning to Meet Major Shifts in Defense Programs.'

Mr. Reese expects industrial and consumer markets for semiconductor products to expand nearly four times faster than the government - defense market. He predicted that the current $43 million European government-defense market may grow to $103 million by 1973.

However, Mr. Reese anticipates the government-defense market growing by 54%, though he forecasts a 188% growth for the non-military. This latter group includes telecommunications, computers, navigation aids, radar and research and development.

Biggest growth is seen in the industrial sector, which may expand from the current $54 million to about $171 million by 1973. This represents a 219% growth including electronic data processing, process and industrial controls, telecommunications, instruments and marine radar.

Mr. Reese expects the consumer sector to increase sales 108%, from the present $50 million to about $103 million by 1973. Radio and television represent the biggest sector here, plus lesser markets for appliances, watches, clocks, toys, hearing aids.

AMPEX OFFICIAL FORECASTS HOME RECORDER SALES

Fast growth of home recorder sales is predicted by John N. Latter, vice president and general manager of Ampex Corp.'s new consumer and education products division, Chicago.

"We estimate in 1964 the U. S. retail market for home recorders at more than $90 million," said Mr. Latter.

He also said that the recorder market is expected to reach $160 million in annual retail sales by 1967.

TV SALES RISING; COLOR TV, ALL-CHANNEL OUTPUT GROWS

Monochrome television sales by units were up this May, compared to May 1963, according to Electronic Industries Association's Marketing Services Department. Radio distributor sales were down, but total production for radio receivers rose.

Distributor sales of monochrome TV sets in May 1964 totaled 396,528 units, compared to 378,215 in 1963. Cumulative total for the year, through May, rose to 2,829,949 units, compared to 2,414,998 in 1963.

Distributor sales of radio receivers (excluding auto sets) totaled 571,989 compared to 598,410 for May 1963; the year's total through May was 3,151,201 compared to 3,123,747 units for 1963.

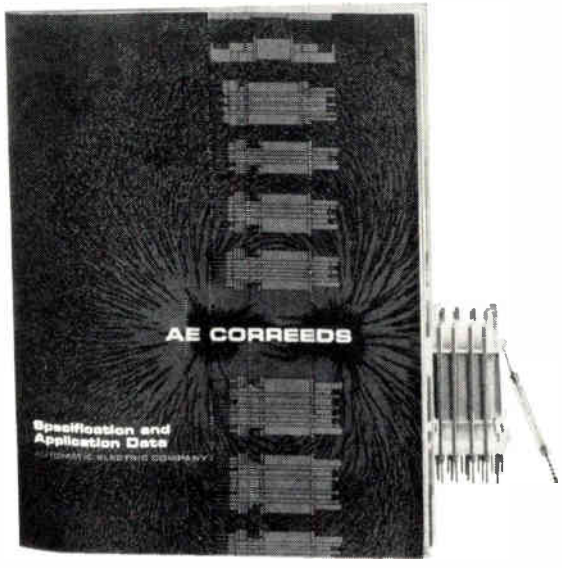
Total TV set production for May, including both color and black and white, was 584,223, and the January-May cumulative total was 3,657,291 units. Color set production total for January-May was 475,620 units. Sales forecast is for 1,000,000-plus color sets in 1964.

Of 487,148 monochrome sets produced in May 1964, 483,219 were all-channel. Less than 4000 sets still had no UHF tuners included.

World Radio History

5 MILLION CORREEDS

are behind this booklet



get your copy free

Learn why AE Correeds are your best route to the speed, long life and reliability of dry reed switching. This booklet gives you facts based on more than 5 years' experience in applying 5 million Correeds.

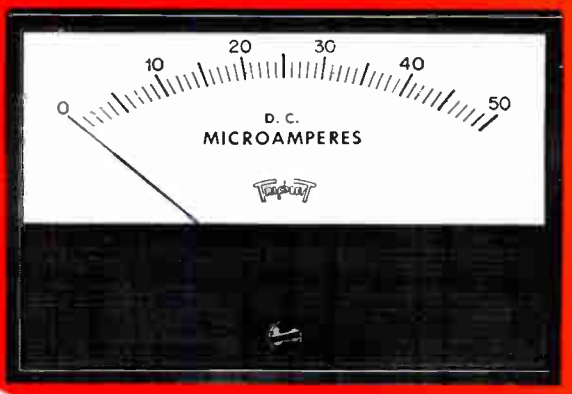
It tells how functional, rugged design protects your circuits against trouble—with straight, unstressed contact terminals that make Correeds virtually immune to changes in sensitivity, and prevent strain or fracture in the reed-capsules—with efficient shielding that permits high-density mounting without magnetic interference—with sturdy molded coil bobbins that provide unusual structural strength.

AE CORREEDS Specification and Application Data also shows you how to put Correeds to work for you. It includes specifications, diagrams, mounting data and ordering information. To get your free copy, ask your AE representative for Circular 1051. Or, write to the Industrial Products Div., Automatic Electric Company, Northlake, Ill. 60164.

AUTOMATIC ELECTRIC

SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS GT&E

World Radio History



R-Series
2-sizes: 3-1/2", 4-1/2"

TRIPLETT

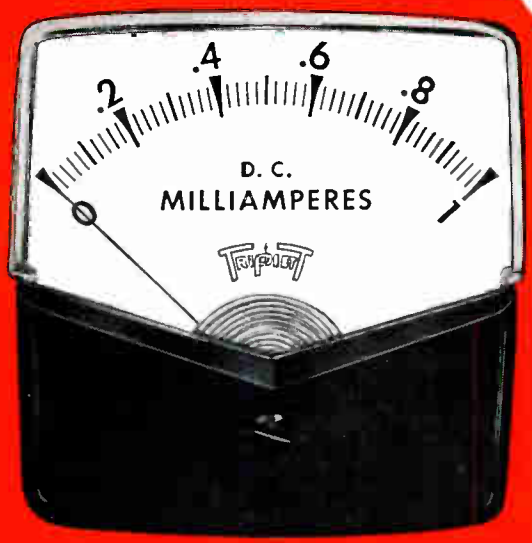
"CLEAN SWEEP" PANEL INSTRUMENTS

A fresh approach to ultra-modern instrument design provides a "clean sweep" of the pointer over the full scale.

1 You get instant readability easier and at greater distances—plus more attractive designs to integrate into your equipment.

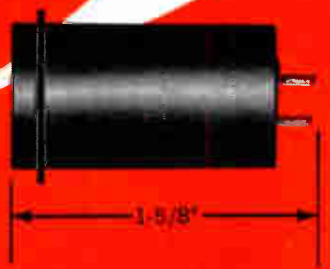
2 Self-shielded, accurate, reliable D.C. instruments have the exclusive Triplett BAR-RING movements.

3 Whatever your panel instrument requirement, look to Triplett for the right size and style, the right capability at the right price.



M-Series
4-sizes: 2-1/2", 3-1/2", 4-1/2", 6"

New 3/4" Meter
Model 758



SHIELDED BAR-RING MOVEMENTS

ALNICO MAGNET IS MOUNTED INSIDE SOFT IRON RING; FULLY SELF-SHIELDED

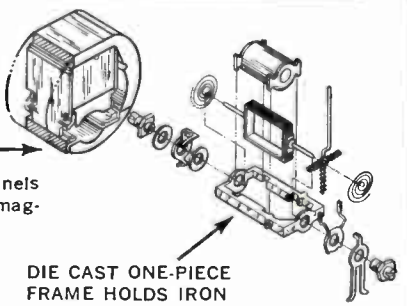
Not affected by magnetic panels or substantially by stray magnetic fields for D.C.

More Torque

Lower Terminal Resistance

Faster Response

Exceedingly Rugged and Accurate



DIE CAST ONE-PIECE FRAME HOLDS IRON CORE IN EXACT ALIGNMENT

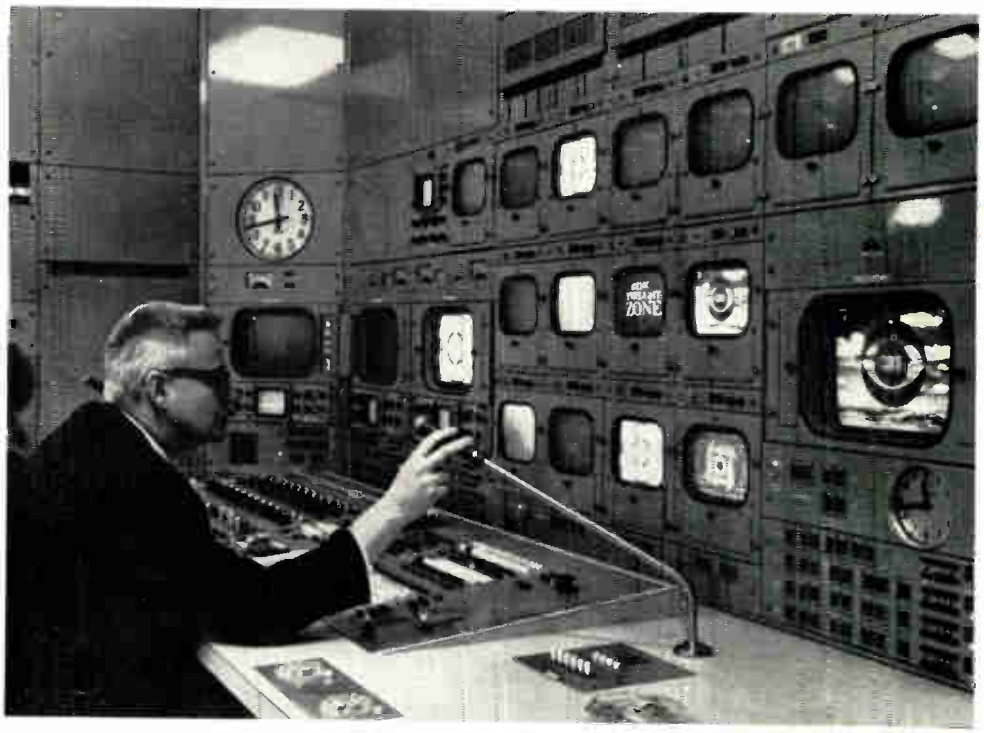
TRIPLETT ELECTRICAL INSTRUMENT COMPANY, BLUFFTON, OHIO

Circle 17 on Inquiry Card

World Radio History

ELECTRONIC SNAPSHOTS...

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



COMPUTER CONTROL

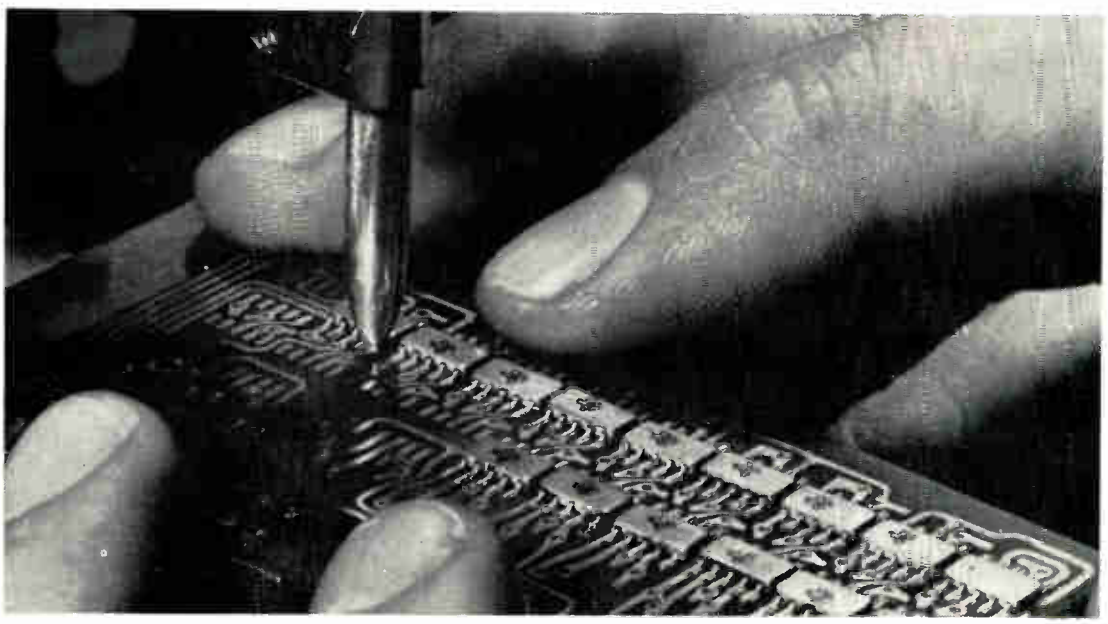
The CBS Broadcast Center in New York City uses two Bunker-Ramo Corp. (New York, N. Y.) control computer systems for network television switching.

STUDYING MASER LIGHT

Scintillating like a star, coherent light generated by an optical maser travels 1½-miles through the atmosphere at Bell Telephone Laboratories, Holmdel, N. J. Bell engineers are studying how this monochromatic light is affected by various types of weather.

CONTROL STUDY

Special 160° f/2.0 projection lens system (r) developed by Fairchild Space and Defense Systems, Syosset, L. I., N. Y., is used at Boeing Laboratory to create visually-realistic space missions to find what man can and cannot do in controlling spacecraft.



SMALLER BY FAR

One of 20 integrated circuits used in the design of this microminiaturized binary decoding unit, is welded into place. Designed at Electronic Communications, Inc., Petersburg, Fla., it is smaller by 50 times than if it used normal circuitry.

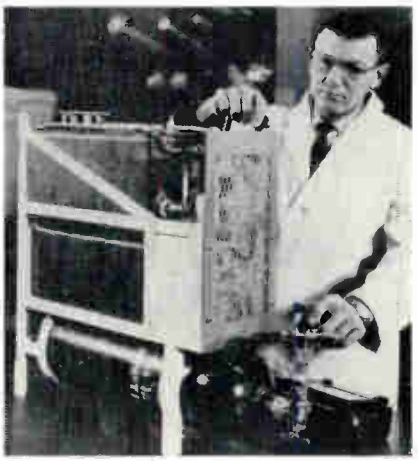
World Radio History

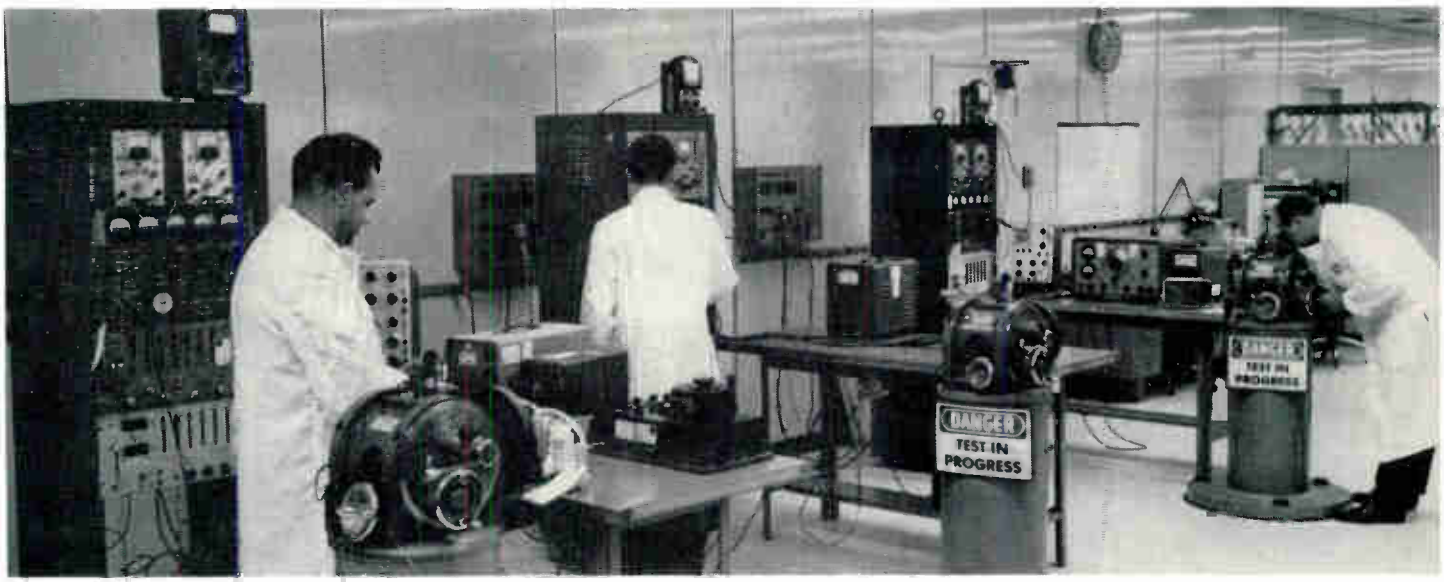
PUBLIC SATELLITE

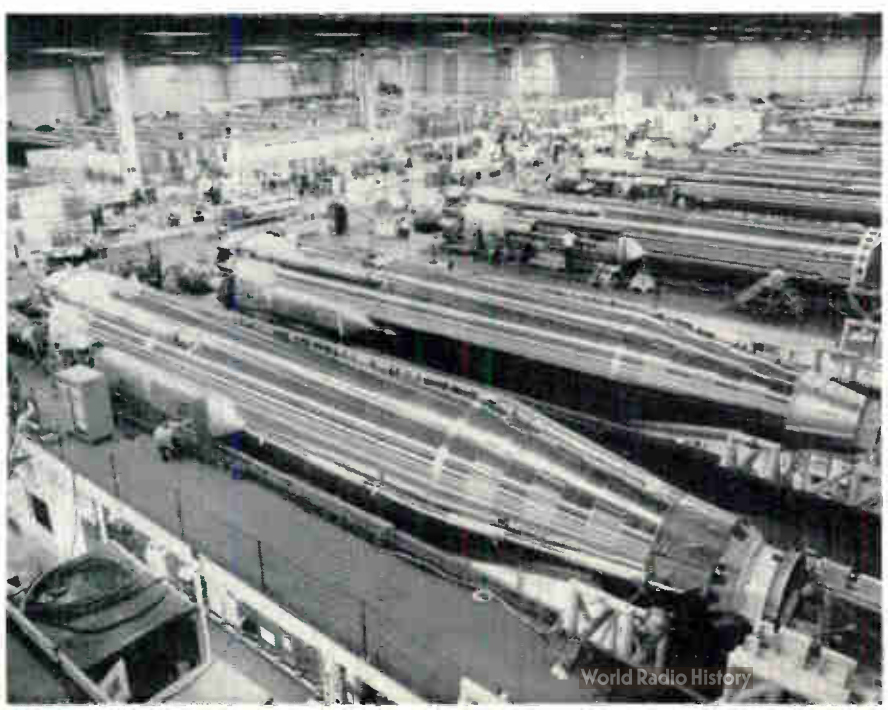
Full-scale model (above) provides a preview glimpse of the world's first commercial communications satellite, which is now being built by Hughes Aircraft Co., Culver City, Calif., for the Communications Satellite Corp. The new satellite will link Europe and the U.S. with telephone, teletype, facsimile and TV.

FUEL CELL POWER

Edward Gillis (below) runs fuel cell developed by Allis-Chalmers of Milwaukee, Wis., for the STAR I, a one-man submarine test and research vessel. The cell converts the energy from hydrazine and oxygen directly into electricity to power the sub's motors, electronic, life support and lighting equipment.







SENSITIVE TESTS

Tests are in progress on highly-precise digital velocity meters in new Avionics "Clean Room" at Bell Aerosystems Co. lab in Buffalo, N. Y. Very sensitive test equipment is installed on stable bases, which are separated from floor and building so that no vibrations are transmitted to instruments during a test.

STANDARDIZED ELECTRONICS

Atlas SLV-3 is shown in assembly and checkout dock prior to acceptance by the Air Force. Standardized autopilot, guidance, tracking, telemetry, and electrical system kits are provided for installation on the basic airframe. The Atlas SLV-3 is built by the Astronautics Div. of General Dynamics Corp., San Diego.

World Radio History

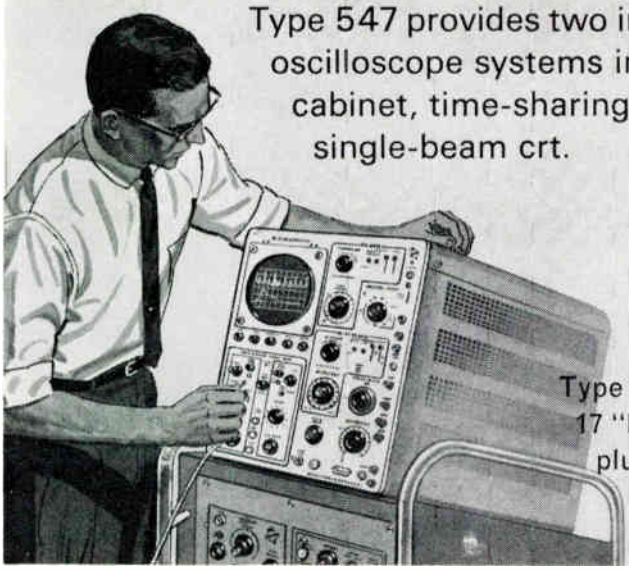
Tektronix oscilloscope displays both time-bases separately or alternately

NEW TYPE 547 and 1A1 UNIT

DUAL TRACE — **DC-to-50 MC 50 MV/CM**
DC-TO-28 MC, 5 MV/CM

SINGLE TRACE — **2 CPS-to-15 MC 500 μV/CM**
(CHANNELS 1 AND 2 CASCADED)

With automatic display switching, the Type 547 provides two independent oscilloscope systems in one cabinet, time-sharing a single-beam crt.



Type 547 also uses 17 "letter-series" plug-in units

Some Type 547/1A1 Unit Features

New CRT (with internal graticule and controllable illumination) provides bright "no-parallax" displays of small spot size and uniform focus over the full 6-cm by 10-cm viewing area.

Calibrated Sweep Delay extends continuously from 0.1 microsecond to 50 seconds.

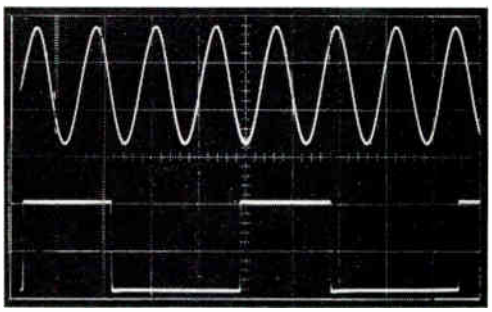
2 Independent Sweep Systems provide 24 calibrated time-base rates from 5 sec/cm to 0.1 μsec/cm. Three magnified positions of 2X, 5X, and 10X, are common to both sweeps—with the 10X magnifier increasing the maximum calibrated sweep rates to 10 nsec/cm.

Single Sweep Operation enables one-shot displays for photography of *either* normal or delayed sweeps, including alternate presentations.

2 Independent Triggering Systems simplify set-up procedures, provide stable displays over the full passband and to beyond 50 Mc, and include brightline automatic modes for convenience.

Type 547 Oscilloscope (without plug-in unit)	$1875
Type 1A1 Dual-Trace Unit	$ 600
Rack-Mount Model Type RM547	$1975

U.S. Sales Prices f.o.b. Beaverton, Oregon



Single-exposure photograph.

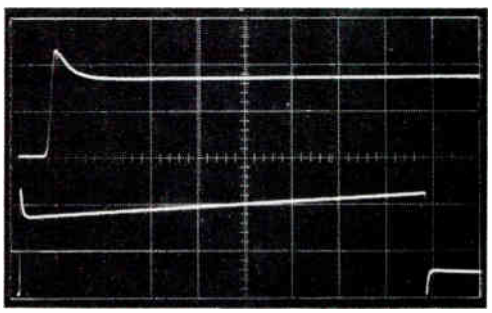
2 signals — different sweeps

Upper trace is Channel 1/A sweep, 1 μsec/cm.
Lower trace is Channel 2/B sweep, 10 μsec/cm.

Using same or different sweep rates (and sensitivities) to alternately display different signals provides equivalent dual-scope operation, in many instances.

Triggering internally (normal) permits viewing stable displays of waveforms unrelated in frequency.

Triggering internally (plug-in, Channel 1) permits viewing frequency or phase differences with respect to Channel 1.

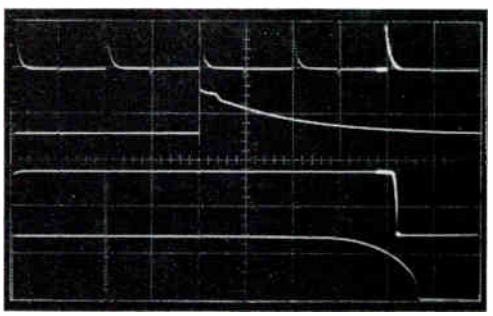


Single-exposure photograph

same signal — different sweeps

Upper trace is Channel 1/A sweep, 0.1 μsec/cm.
Lower trace is Channel 1/B sweep, 1 μsec/cm.

Using different sweep rates to alternately display the same signal permits close analysis of waveform aberrations in different time domains.



Single-exposure photograph.

2 signals — portions of each magnified

Trace 1 is Channel 2/B sweep, 10 μsec/cm.
Trace 2 (brightened portion of Trace 1) is Channel 2/A sweep, 0.5 μsec/cm.
Trace 3 is Channel 1/B sweep, 10 μsec/cm.
Trace 4 (brightened portion of Trace 3) is Channel 1/A sweep, 0.5 μsec/cm.

Using sweep delay technique—plus automatic alternate switching of the time bases—permits displaying both signals with a selected brightened portion and the brightened portions expanded to a full 10 centimeters.

B sweep triggering internally from Channel 1 (plug-in) assures a stable time-related display without using external trigger probe.

For a demonstration, call your Tektronix Field Engineer

Tektronix, Inc. / *P.O. BOX 500 · BEAVERTON, OREGON 97005 · Phone (Area Code 503) Mitchell 4-0161 · Telex: 036-691*
TWX: 503-291-6805 · Cable: TEKTRONIX · OVERSEAS DISTRIBUTORS IN 25 COUNTRIES
TEKTRONIX FIELD OFFICES in principal cities in United States. Consult Telephone Directory

Tektronix Australia Pty., Ltd., Melbourne; Sydney • Tektronix Canada Ltd., Montreal; Toronto
Tektronix International A.G., Zug, Switzerland • Tektronix Ltd., Guernsey, C. I. • Tektronix U. K. Ltd., Harpenden, Herts

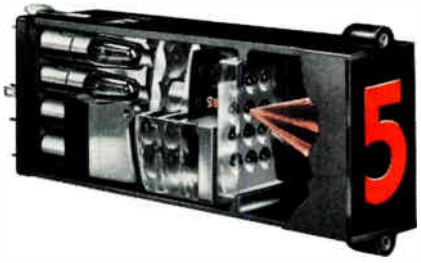
World Radio History

SOME COMMON SENSE OBSERVATIONS ON READABILITY OF READOUTS

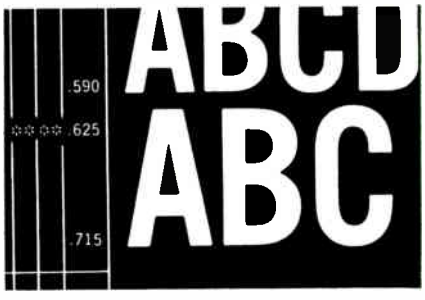
WHAT GOOD IS A READOUT THAT'S SEEN BUT NOT READ?

That may seem like an odd question, yet daily we're finding examples of readouts that provide far less than the best in readability. Yet, what's a readout for, if not readability of the highest order? The whole purpose of readouts is translation of electrically transmitted information into easy-to-read messages.

This cut-away of a typical IEE readout will give you some idea how the device operates to provide optimum readability:



First, the presentation is single plane: only the message that's "on" is visible. What's even more important, the message is projected from a film. Hence, an IEE readout can display anything that can be put on film, including numbers, letters, words, even colors and symbols. Thanks to this display versatility, you can order your IEE readouts with a character style that has been proved by human factors engineers as being most legible to the average reader. A section from our sample type sheet gives an example of a commonly used type style. Since these readouts can display anything that's photographically reproducible, any type style may be used. This enables us to meet every military and human engineering specification known.



Compare these big, bold characters with the segmented characters used for most electro-luminescent and incandescent bar segment readouts. These readouts contain a matrix made up of a number of segments with selected ones lighted to make up the display. As a sample, the next sentence is composed of these characters, photographically reproduced here without any change:

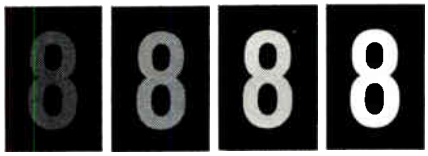
SPEED AND ACCURACY OF READING DROPS BECAUSE ALL OF THESE CHARACTERS ARE SIMILAR

There's another serious problem with this type of readout. Suppose that the reading calls for a figure *8*. If a specific segment fails, the indication will show *6*. Or, if a different segment fails, the figure *8* could show up as *9* — project this situation to a digital altimeter in an aircraft. Then hope that the difference between say a reading of 9,000 feet and an actual 8,000 doesn't involve contact with a mountain peak! We can only conclude that a readout should be seen but not mis-read.

THE BC RATIO FOR READABILITY

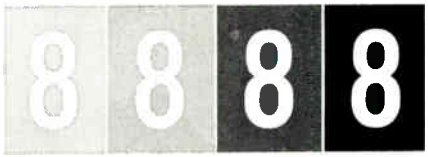
B is for Brightness, C is for Contrast — the two work together to give you a crisp, highly legible message. One won't do without the other, and in proper ratio at that. Consider the gas ionization readout with its glowing filaments: you get plenty of brightness but where is the contrast? But let's take them one at a time:

BRIGHTNESS



This is a reasonable facsimile of how character brightness affects readability despite a constant strong background contrast. IEE readouts offer up to 90 foot lamberts of brightness. But brightness can't be the sole basis for measuring readability...

CONTRAST



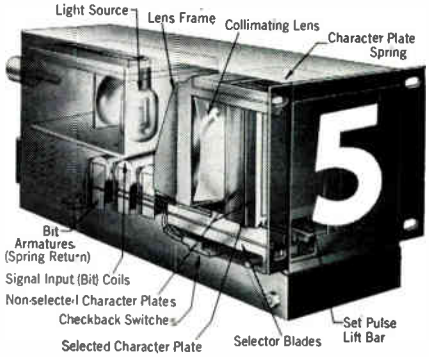
Here we've kept the character brightness constant but varied the background until we achieve proper contrast at far right. It's quite obvious — brightness without contrast doesn't do much for readability. IEE readouts provide the proper ratio of brightness and contrast for visual crispness and unmistakable clarity at wide angles, long viewing distances, even under adverse high ambient light conditions. In short, IEE readouts are the most readable readouts made. That's part of the reason we're so partial to them.

PULSE CODE RECEIVER BY VAREC, INC.
Subsidiary of Microdot Inc.

VISUAL TRANSLATION BY IEE

The Varec/Dynel Pulse Code Receiver decodes and displays liquid level, pressure, flow rate, and temperature data gathered from remote locations by their high speed telemetering system. Giants of the chemical, petroleum, and food processing industries have installed this system for continuous control over things that bear some watching. To make sure that the watching is highly watchable, Varec engineers specified the most readable readouts made. We made the readouts.

THIS IEE READOUT DECODES, DISPLAYS, REMEMBERS



IEE Bina-View® is a binary input, self-decoding readout with a complete alpha-numeric capability. Decoding is entirely self-contained; no external translators, relays or diodes are required.

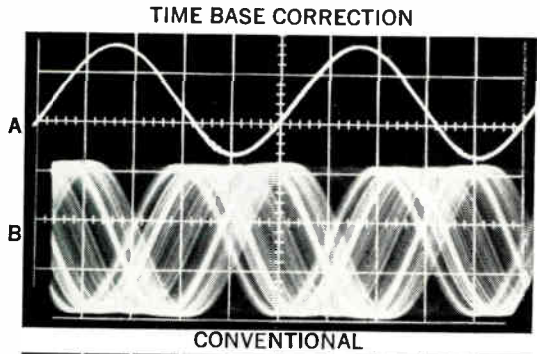
Its 41-message capacity permits additional display of colors, symbols, words. Floating decimal points are available from a separate lamp circuit.

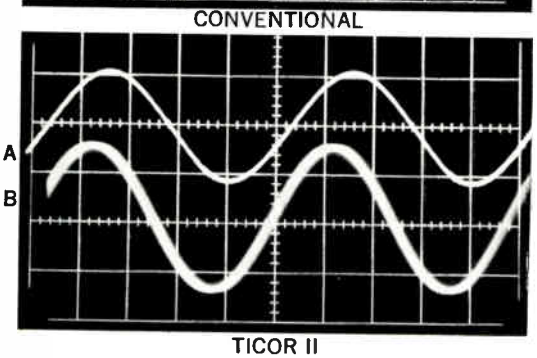
Bina-View also provides automatic memory and retains the last message displayed after signal and set-pulse power have been removed. As an optional feature, Bina-View may also include auxiliary contact closures that can be used for check-back to verify input signals and to transmit input signals back into source equipment.

©1964 IEE

INDUSTRIAL ELECTRONIC ENGINEERS, INC. *Representatives in Principal Cities*
5528 Vineland Ave. • N. Hollywood, Calif. • Phone: (213) 877-1144 • TWX: (213) 769-1636

World Radio History





TICOR II

TRACE A: 100-kc oscillator reference signal
TRACE B: 100-kc line driver output, track 13
One-inch tape, speed 60 ips. Sweep rate: 2.0 μsec/cm.
Photo exposure: 1/25 sec.

EXCLUSIVE STORY ON MINCOM'S NEW 1.5-mc TICOR II

On playback, lock in your tape reference track to TICOR II's reference oscillator signal—the traces above demonstrate a time-base correlation between events holding well within ±0.5 μsec, continuously anywhere on the tape. This unique and exclusive Mincom 1.5-mc recorder/reproducer immediately updates any existing data reduction center. It opens new doors to data analysis in radar recording, single sideband, serial PCM and other systems dependent on precise time-base stability. Flutter components below 200 cps are essentially removed. Rapidly convertible from ½-inch to 1-inch tape, all solid state, one equipment rack, RFI-shielded. Write for specifications.

Mincom Division 3M COMPANY

300 South Lewis Road, Camarillo, California • 320 Shaw Road, South San Francisco, California • 529 Pennsylvania Building, 425 13th Street, N.W., Washington, D.C. • 135 West 50th Street, New York, New York • Post Office Box 272, Fairborn, Ohio • 1230 Orange Avenue, Winter Park, Florida • 2121 Santa Anna Avenue, Dallas, Texas • Eltron Engineering Sales, Inc., 246 Walnut Street, Newtonville, Massachusetts

Circle 25 on Inquiry Card →

World Radio History

Fill the Industrial 10-Turn Potentiometer Gap for Under $5

This new, low-cost ⅞"-diameter potentiometer is the latest addition to the famous Bourns potentiometer family — and less than $5 puts it into your applications.

Almost ½" shorter than competitive units, it helps you keep over-all system size down. Despite its compactness, it has resistances from 100 ohms to 100,000 ohms, together with standard linearity of ±0.5% and resolution to 0.01%. Part of the secret behind this achievement is a unique design that allows us to put a 10% longer resistance element in the shorter package.

In industrial application environments, the Model 3507 offers you the superior reliability you expect. You can operate it at 105° C, in steady-state humidity, and under conditions of 10 G vibration and 50 G shock. Like other Bourns precision potentiometers, it incorporates the exclusive, indestructible SILVERWELD® termination and is subjected to rigorous tests to assure full compliance with specifications.

Don't settle for a compromise in your industrial or commercial system — specify the Bourns Model 3507! It's available now! Write today for free technical information.

Temperature range	−55° to +105°C
Rotation life	200,000 shaft revolutions
Independent linearity, max.	±0.5%
Power dissipation	2 watts @ 25°C
Noise, max.	100Ω ENR

ONE-HALF ACTUAL SIZE

Mil Type
Multi-Turn Precision
Potentiometer

Low-Cost
Industrial Multi-Turn
Potentiometer

Commercial
Multi-Turn Potentiometer

BOURNS

BOURNS, INC., TRIMPOT DIVISION
1200 COLUMBIA AVE., RIVERSIDE, CALIF.
PHONE 684-1700 · TWX: 714-682 9582
CABLE: BOURNSINC.

MANUFACTURER: TRIMPOT® & PRECISION POTENTIOMETERS, RELAYS; TRANSDUCERS FOR PRESSURE, POSITION, ACCELERATION. PLANTS: RIVERSIDE, CALIFORNIA; AMES, IOWA; TORONTO, CANADA

World Radio History

ELECTRONIC INDUSTRIES
STATE-OF-THE-ART
FEATURE

MICROELECTRONICS— WHERE, WHY AND WHEN?

The potential benefits of microelectronic technology sometimes stimulate an enthusiasm to use these methods and circuits almost everywhere and without delay. The authors are concerned with this attitude. As a result they have outlined where microelectronics should be used, benefits of its use and problems that need to be solved.

By JOSEPH B. BRAUER
Chief, Solid State Applications Sectio
and EDWARD P. O'CONNELL
Chief, Techniques Group,
Solid State Applications Section,
Rome Air Development Center,
Griffiss AFB, N.Y.

As members of a Government research lab responsible for applying microelectronics to military needs, we are very interested in promoting the best transition into this new technology. We are concerned with attitudes that this is just another encroachment by the solid state researcher into vacuum tube circuits. We are equally disturbed by designers who wish to use only microelectronic approaches regardless of cost, performance, or necessity. These approaches will stymie development progress long before the full potential is realized. It is the intent of this article to outline where microelectronics should be applied, benefits to be derived from its use and certain problem areas that need further attention.

* * *

The proven capability to provide large size, weight, reliability and cost advantages in certain uses has created an aura of "goodness" about microelectronic technology. It has also created the implication that use of any such method is a guarantee of instant success. As with any technological advance, it is essential that the use of microelectronics be guided by both engineering and economic considerations. Also, a good engineering job demands full consideration of problems and disadvantages as well as advantages. For example, direct "transfer-design" or one-for-one replacement of the parts in a discrete-component, transistorized circuit do not assure a proper reflection of integrated circuit capability. Nor will a procurement document calling for "total molecularization" of a piece of equipment which contains circuits characterized by power levels, frequencies or other needs obviously beyond the capabilities of microelectronic methods. It may have been somewhat justified in early exploratory phases to talk glibly about "inherent reliability" on untested circuits, the "two-dollar module" on circuits costing many times that amount and "400mc capability" on circuits which can be useful only with a variety of attached discrete components. But, when it comes to applying microelectronics to specific operational needs with hard specs on performance, reliability, environmental resistance, size, weight, etc., the moment of truth has arrived. This transition from exploration to use of microelectronics has come with a suddenness which testifies to the effectiveness of the sales campaigns which have been waged. The next few years will reveal how well our technical homework has been done in support of these campaigns.

Definitions

To avoid confusion regarding microelectronic terminologies now being used, the following meanings will be used here.

Thin Film Circuits: All the passive components and conductors are formed on passive substrates by spray, vapor, sputtering or plating processes with the active elements then attached.

Semiconductor Integrated Circuits: All passive and active elements needed to perform a specific electronic function are formed in or on the semiconductor substrate by diffusion and/or epitaxial growth processes.

Hybrid Circuit: Thin film passive components added to semiconductor integrated devices as overlays or "chipped" semiconductor devices.

Standard Circuit: A circuit designed by the vendor and available as an off-the-shelf item.

Custom Circuit: A circuit designed and built to the buyer's specification.

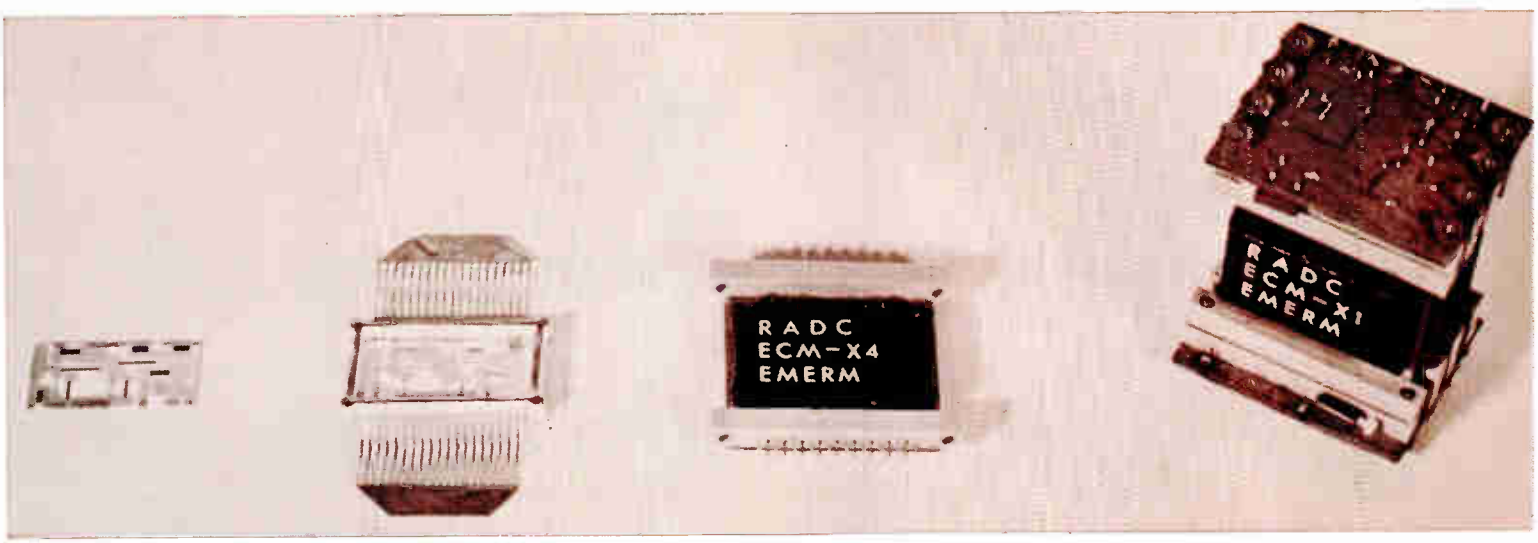
Customized Circuit: A circuit using a standard configuration of vendor's components that have been interconnected to satisfy specific needs of the buyer.

Technical Status

In specifying the current status of microelectronics, one must consider in addition to the above approaches, discrete miniature components. This category consists of modules, pellets, cordwood assem-

World Radio History

Thin film ECCM receiver. Normal transistorized and vacuum tube designs (background) are compared to an equivalent thin film unit. Alumina substrate and metal-ceramic package (photo below) are shown with interim assembly used in evaluation of circuit interchangeability and reliability.



blies, etc. Their status is limited primarily by the component selection available today, and it is not expected to be greatly improved in future years. Miniature discrete components offer the advantage that they are now available, are flexible in design and breadboard phases, have tunable components, provide inductive elements and operate at high frequencies. These features make them well suited for linear circuit uses. It is estimated that discrete components, including miniature versions, will satisfy about 35% of the military electronics needs for years to come.

Thin film circuits have much potential, particularly if a method for depositing reliable active devices directly on the substrate can be perfected. Much research in this area is now being sponsored both by industry and the military. But, progress has been slow and much work remains before production capability can even be forecast. Thin film circuits do show good fabrication tolerances (mfgr. tolerances can be held to a few percent and "trimming" can reduce them still further) and many film components have very good temperature stability. *(Continued)*

World Radio History

The operating frequency of thin film circuits is sufficiently greater than semiconductor integrated circuits to make them attractive for linear device uses at frequencies above 10 MC. Fig. 1 shows a plot of relative gains for thin film and integrated circuits. It can be seen that an order of magnitude improvement in gain is possible with film circuitry primarily because parasitic coupling is reduced. The hybrids, of course, reduce the margin between either method, which explains their very existence.

Semiconductor integrated networks are the most advanced microelectronic technology today. Several systems designed for space uses are using monolithic silicon circuits in their data processing equipments. This approach is now available almost solely for digital-logic functions and is encountering difficulty in satisfying the demand because of low yields. This is especially true for custom circuits, where the buyer's lack of integrated circuit design experience has overcomplicated the processing. Even so, semiconductor integrated circuits are here to stay and will in the not too distant future satisfy over 80% of the digital function needs for military electronic systems.

The term "hybrid circuit" is used to define microelectronic approaches where more than one method is used to achieve a given function. Semiconductor hybrids, where the passive component films are applied as overlays to a semiconductor substrate, are still not a routine production item. Several vendors have made good progress and have operating devices, but again more research work is needed before this approach is ready for production.

Semiconductor "chipped" circuitry is another hybrid approach that will play an important role, until the semiconductor integrated devices have obtained the refinement in processing needed to extend their capabilities. The semiconductor chip approach overcomes coupling limitations of the single chip and can be used extensively to satisfy linear function needs. Careful design of "chipped-up" circuits can be used to simulate all features of a future monolithic design and at a fraction of the cost. But, it is not true that any circuit which can be made in chipped form is amenable to monolithic fabrication.

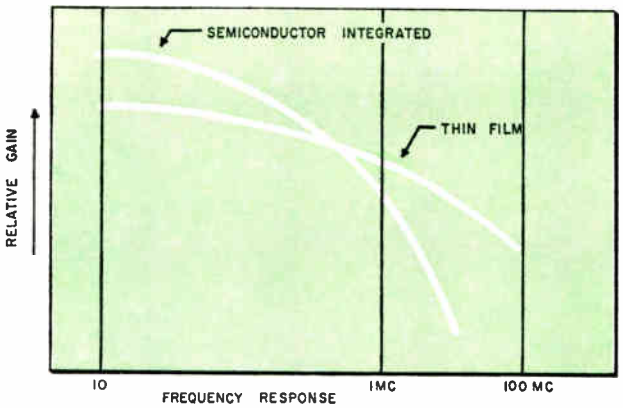


Fig. 1: Relative gains for thin film and integrated circuits are plotted at left.

Where Will Microelectronics be Used?

The basic test in determining where it should be used is, "Does it do the best job?" In making this analysis, advantages to be achieved in size, weight, reliability and power consumption must be compared with the penalties of higher initial cost, non-availability of certain elements or functions and limitations in design flexibility. Once the need for microelectronics has been established, a suitable approach must be selected. Since many grandiose claims have been made regarding the capabilities of various methods, extreme care must be taken to base this decision on sound engineering judgment. There does not exist today a singular microelectronic approach that will provide all twenty plus functions used in military electronic systems. Thus, when multiple function systems are needed, thought must be given to optimizing performance through hybrid methods. This is especially true for data acquisition and transmission equipments where most functions are of the linear type and usually involve higher frequencies and power levels than the digital types.

In considering where microelectronics can be used, one must look at the makeup of military electronic systems. Fig. 2 shows the two basic categories of equipments, "Data Processing and Storage" and "Data Acquisition, Transmission and Control," and the percentage of each that is used. The latter, which consists of Radar, Communications, Countermeasures and Navigation equipments, accounts for 75% of military electronic needs. Computers, logic circuits, and other data processing equipments account for the other 25%. Type of functions used in the acquisition and transmission category is about 80% linear and 20% digital, while the use in data processing and storage equipment is exactly the reverse. Fig. 3 shows an estimate of where microelectronics will be applied in the 1970's. It is predicted that for digital functions, 70% will be semiconductor integrated, 16% film and hybrids, and 14% discrete; in linear circuitry, 45% will be discrete, 40% film

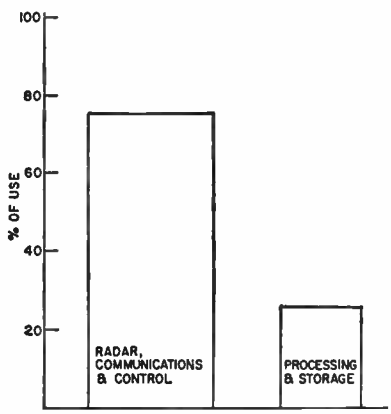


Fig. 2: Two basic categories of military electronic equipments and the percentage of each that is used.

World Radio History

and hybrids, and 15% semiconductor integrated.

Thus, the linear circuit area will provide a large percentage of the military electronics market and will be a primary target for extending microelectronic capabilities during the next decade. Particular functions that will be needed are amplifiers operating at 30 MC and above, signal generators, bandwidth and amplitude shaping circuits, tuning devices, switches and gating functions.

It has been shown that microelectronics will be used in combination with other methods in all types of military electronic equipment. It should be applied only where it will do the best job. This demands that a proper design job must superimpose the technology on a time scale to find the "best-job" as it will exist at the time feasibility or developmental models go into production. This precaution to insure the fullest use of advanced microelectronic methods is often overlooked, despite its equal usefulness in any design effort. This will insure continued growth and maturity of microelectronics toward the end objective; more reliable, less costly electronic systems.

Impact of Microelectronics

Standardization and Performance

The unfortunate histories of some standardization programs for electronic circuits have made this perfectly legitimate engineering term a controversial subject. Attempts at standardization during the infancy of a new technology restrict its growth and limit its end potential. But, at the same time, microelectronic circuits must be produced in quantity and on a continuous production basis to ever achieve low cost production, establish any reliability levels, or establish firm performance characteristics.

Some relief is provided by the ability to customize circuits by varying only the interconnection patterns on a master wafer. Uniform production criteria apply to the wafer processing up to the final interconnection steps. It is still essential that high-yield, rigidly-controlled production processes serve a large quantity need to amortize the costs of about $10,000/mask set for a silicon solid circuit, or $3,500/mask set for a film circuit, plus $XX,XXX for automatic performance and reliability testing setups.

Perhaps a better word for what is needed is the old term commonality—applied at both the circuit and system level. This dictates the greatest numerical use of the least number of unique circuits or subassemblies in a given equipment or system. Equipments designed for microelectronic circuits do not need to recognize the old fashioned environmental and use boundaries between ground and airborne uses or between manpack and vehicular mounted conditions. (Boundaries have become fairly artificial with transistor circuits in any event.) Designs can more readily be optimized to fit a variety of uses. Common use of major equipment packages or subsystems involves a high level of inter-system and inter-Service cooperation and coordination. Of equal importance is functional design at the lowest level. Equipment such as the MTI canceler (a current RADC development effort) provides an example of the latter. Use of normal linear circuits with a delay line involves some 10 to 15 different circuit types exclusive of the power supply. The alternate range-gated filter approach uses only one circuit type in quantity. It simultaneously affords a high level of parallel redundancy which also desensitizes the equipment to the first few failures. Predicted performance of the range-gated filter approach is also superior to the normal design.

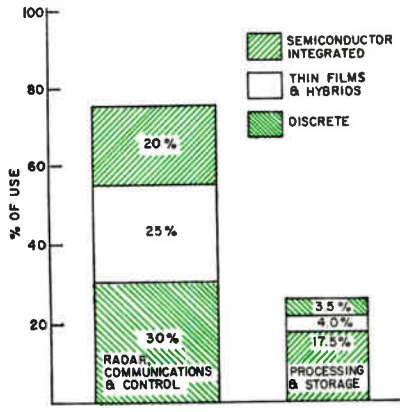


Fig. 3: Probable use (1) of microelectronics in military equipment in the 1970's.

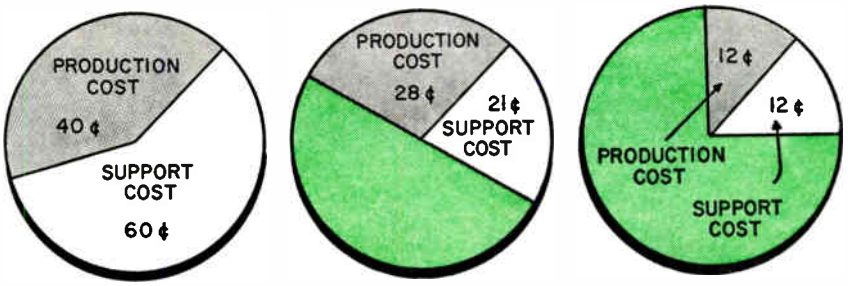


Fig. 4: Breakdown of average price and annual support costs (a) with today's equipment and conventional discrete circuit form, (b) with today's integrated circuits and (c) with integrated circuits by 1970.

Procurement Barrier

Low bid procurement practices place at a disadvantage any methods which incur high initial design and development cost, but greatly reduce the later production cost. There is also a tendency to use Fixed Price contracts for equipment procurements even on a developmental basis. Part of the blame must be borne by microelectronic suppliers who have in the past allowed their enthusiasm at proposal time to lead to monstrous overruns. Part of it must be associated with the normal lack of user confidence in any new technology until somebody else has taken the "bid gamble." The prevalent tendency toward "trademark dissimilarity," "weekly circuit updating," and "single circuit reliability data" (or even a sample of 10 for a failure rate of 0.001%/1000 hrs) certainly does not help to build user confidence. *(Continued)*

World Radio History

One answer lies in use of in-house or contractual preliminary design studies to insure maximum system effectiveness at lowest total cost—including costs of design, development, production and support. This decision would then be reflected in a contract to buy the equipment development with bid competitions all based on the specific design and circuit technology found to be most appropriate in the preliminary studies. Where bids were solicited on similar technologies, there should be little concern about the type of contract. No bidder could "buy" the contract by using a smaller percentage of more advanced or costly methods. The bid list would, of course, have to be limited to responsible sources. And, there would have to be mutual trust and respect on the part of both parties to the end contract. Without these conditions no contract is likely to accomplish its objectives. To summarize, it is probable that the real "procurement barrier" revolves around the question of what we really want to buy rather than how to buy it. Time and experience with microelectronic methods may prove that the greatest problem is a complete lack of information as to what one can buy or what is really available. When a contract is offered calling for specific performance and reliability needs and stating that demonstration or proof of their achievement is needed, the offeror is paying the bills for the vendor to show that his product can meet its claims. This would seem like a mutually beneficial arrangement. The vendor who objects courts the suspicion that he either doesn't know his product's capability or knows enough about it to fear that it cannot meet the competition.

Mission Costs

Total mission cost of any equipment or system is the sum of the initial cost price and the cost of support (including maintenance, supply and transportation) for the life of the equipment. A recent survey (Raytheon and RADC) indicates that, with normal discrete component circuits, annual support costs run about 1.5 times the total initial price of equipments. Actual figures vary from about 0.6 times for large radars to as high as 12 or 13 times for communication equipment. Multiplying these annual costs by a 5 to 10 year average lifetime makes support costs a source of primary concern.

As for initial price, a recent survey sponsored by the Navy indicates a price range for normal circuits (consisting of one active element group, a tube or transistor and its associated passive components) of $10 to $43 per circuit. This makes the current price range of integrated circuits (consisting of 1 to 4 active element groups) look very attractive. Reliability of current integrated circuits is 2 to 3 times better than normal military grade discrete circuits. With circuit prices figured on the basis of large scale production, and reduced maintenance and other support costs provided by improvement in reliability and design, we may anticipate big reductions in the total cost of military electronics. Fig. 4a shows the breakdown of average price and annual support costs with current equipment and normal discrete circuit form. Fig. 4b indicates a 50% reduction in those costs using current integrated circuits in uses where it is now possible to do so. Fig. 4c brings out the significant reductions which foreseeable price and reliability improvements can mean to at least 40% of total Air Force electronics. This 40% figure is a minimum objective for conversion to integrated circuits by the early 1970's.

Here we have a unique situation in electronic circuits and equipment. For the first time, to our knowledge, we are able to buy higher predicted reliability and performance at a lower cost.

Summary

To summarize technical and economic factors in the context of "Microelectronics—Where, Why, and When?" the following conclusions may be drawn:

(1) Much more data is available on the cost, process control and reliability of semiconductor integrated circuits than on the film or other circuit technologies. Their cost and reliability advantages have been demonstrated and they are being used in military equipment.

(2) Extension of integrated circuit use will be actively promoted within the Air Force with anticipation of some 40% minimum usage by the early 1970's.

(3) ("Thick film" circuits which have been used in "all-passive" circuits for many years will find increased usage in the foreseeable future as they accumulate reliability and cost history.) Thin film circuits face a variety of problems not the least of which is adequate environmental protection. We favor giving them hermetic packages and going to larger sizes and more complex circuits to minimize the additional cost.

(4) Perhaps the most serious deficiency in the entire microelectronics area is the lack of enough "hard" data relating circuit performance to system needs along with all the elements of cost which the designers of electronic systems need to predict in quantitative terms the total cost and total worth of the systems in either normal or microelectronic form.

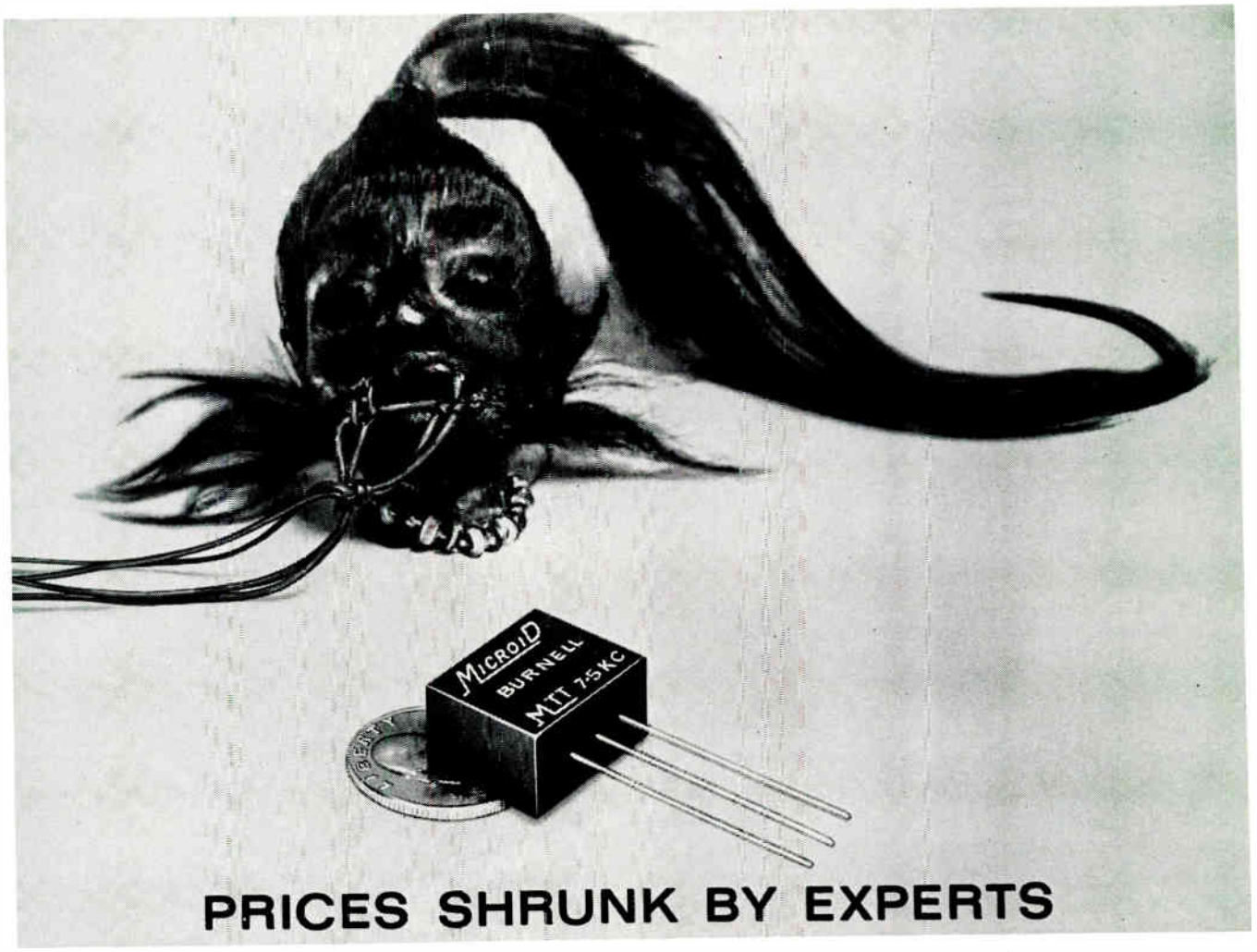
(5) To reduce the lag between capability and effective usage of microelectronic methods, the Air Force is taking steps to:

Build a learning curve for microelectronics technology by introducing it into the inventory of operational equipment.

Expand the inventory of available circuits and criteria for their optimum use.

Establish procedures for carryover of reliability data beyond specific circuits or processes so that the low failure rates anticipated do not demand repetitious and costly testing programs or obsolete the circuits before the data becomes available.

World Radio History



PRICES SHRUNK BY EXPERTS

(Find out just how competitive Burnell is)

Quite some time ago, Burnell established a reputation in the industry as a shrinker of circuits. However, we've discovered that many engineers and P.A.'s were not aware of the fact that Burnell is equally adept at shrinking network costs without sacrificing performance or reliability. Here's how.

There's an infinite number of combinations of configurations, components, and component values to choose from while designing a filter, all of which will produce the same or similar results. However, through computer analysis, Burnell can quickly and accurately determine which combinations will offer the highest performance with the least number of components at the lowest possible prices. Already programmed are thousands of successful filter (network) designs. By feeding your basic requirements into the computer, Burnell can obtain design specifications from its previous experience, which generally will result in lower costs.

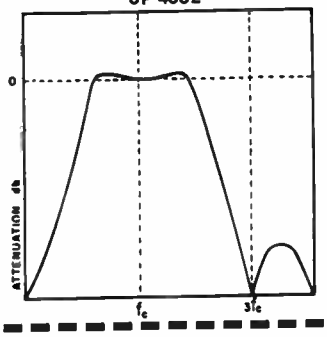
It is not uncommon for Burnell to advance the state of the art to fill a customer's requirement. Example: the best previously available reject filter with certain characteristics had a 10:1 reject to pass band ratio; Burnell made it 2:1. Burnell filters are manufactured in accordance with MIL-F-18329B and MIL-T-27.

Regardless of your present source, do not take for granted that you're getting the highest performance at the best possible price. Check with Burnell and be sure. Fill in this coupon today and start the circuit savings process now.

Some standard catalog items — each of which has been programmed on our computer's tape so as to provide desired variations.

- **Standard Telemetering Filter** — the old workhorse from 400 cps to 70,000 cps.
- **Miniaturized Band Pass Filter**—equivalent to the standard type, but 80% smaller.
- **Specialized Telemetering Filters** — excellent for plug-in printed circuits. Weight: 1.25 oz. Size: .785 cu. inch.
- **Constant Delay Band Pass Filter** — constant within 5% to eliminate ringing and minimize distortion.
- **Zero Phase Shift Filters***—eliminate complex circuitry in servo systems.
- **Active Networks**—cross the twilight zone where the LC or crystal filter isn't practical.
- **Crystal Filters** — available from 5 kc. to 50 mcs. We can make them down to 1 kc (but we aren't satisfied with the reliability of existing materials).

* **Typical curve-Zero Phase Shift Filter OP 400L**



Burnell & Co., Inc.
PIONEERS IN microminiaturization OF TOROIDS, FILTERS AND RELATED NETWORKS
EXECUTIVE OFFICE AND PLANT
Pelham, New York • 914, PElham 8-5000
Teletype Pelham 3633 Dept. E1-48
PACIFIC DIVISION Albuquerque, N.M.
SUBSIDIARIES: G-K electronics inc., Pelham, New York • GLP electronics, inc., Bristol, Conn.

OK, Burnell. Here's your chance to prove that your prices are as good as your products.

- ☐ Attached are my current requirements.
- ☐ Please have your local representative contact me.
- ☐ I need more information. Please send your latest catalog.
- ☐ I've heard about your Space Shrinkers Club and I want to join. Please send application form.

Name.....
Title.....
Company.....
Address.....
City.....Zone.....State.....

World Radio History

Our first Microglass diode customer came in a helicopter

The MICROGLASS diode was still secret. But somehow word leaked out.

So, lo and behold, one sunny morning a helicopter landed at our front door. Out popped our first customer – eager for more information.

He was sworn to secrecy. And given the MICROGLASS story.

There was only one thing that we couldn't then provide: life test data. But now we can. Today MICROGLASS diodes have successfully completed several thousand hours on extended life tests under military standard conditions.

Write for further information: Hughes Semiconductor Division, 500 Superior Ave., Newport Beach, California. Or just phone. You needn't come in a helicopter.

HUGHES

HUGHES AIRCRAFT COMPANY
SEMICONDUCTOR DIVISION
NEWPORT BEACH, CALIFORNIA

World Radio History

PRIMARY ELECTRICAL CHARACTERISTICS

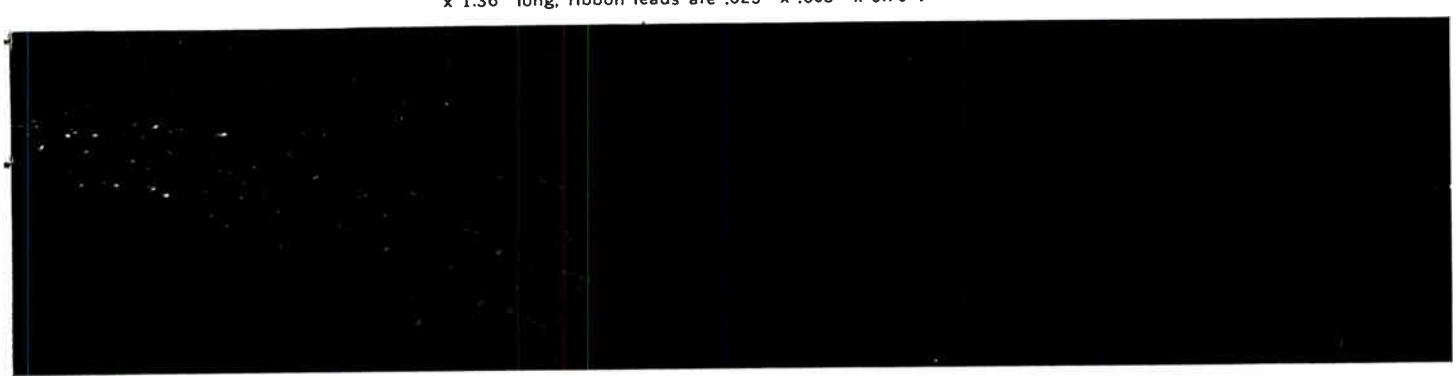
STANDARD HUGHES TYPES	Min. Bv @ 100μA (volts)	MIN. FORWARD CURRENT @ 1V (mA)	MAX. REVERSE CURRENT @ 25°C (μA)	@ 150°C (μA)	@ V (volts)	MAX. CAP @ 0 Volts (pf)	REVERSE RECOVERY AND CONDITIONS # I_f (mA)	V_R (volts)	I_{Rec} (mA)	Ckt —	Max. Time (nsec)
9001	100	100	.025	100	20	3	10	6V	1	S-S	2
9002	100	30	.025	100	20	2	10	6V	1	S-S	2
9003	75@5μA	200	.050	100	50	2	10	6V	1	S-S	2
9004	75@5μA	100	.050	100	50	2	10	6V	1	S-S	2
9005	75@5μA	20	.050	100	50	2	10	6V	1	S-S	2
9006	50@5μA	300	.100	100	40	3	10	6V	1	S-S	2
9007	50@5μA	200	.100	100	40	2	10	6V	1	S-S	2
9008	50@5μA	100	.100	100	40	2	10	6V	1	S-S	2
9009	50@5μA	20	.100	100	40	2	10	6V	1	S-S	2
9010	30@5μA	10	.100	100	20	3	10	6V	1	S-S	2

Additional Reverse Recovery Parameters Which are Guaranteed are: Conditions $I_f = I_R$ from 10mA to 200mA Recovery Current = .1I_f Recovery Time ≤ 4 nsec

DESIGN CAPABILITIES:	DO-7	Silver Clad Nickel Leads	Silver Leads	Ribbon Leads	Rivet	Pellet
Power Dissipation (mW)	250	500	500	150	500	500
Average Rectified Forward Current (mA)	75	150	150	75	150	150
Forward Surge 1 sec (amps)	.5	1.0	1.0	.5	1.0	1.0
Forward Surge 1μ sec (amps)	2.0	4.0	4.0	2.0	4.0	4.0
Temperature, Storage	← −65°C to 200°C →					
Temperature, Operating (ambient)	← −65°C to 200°C →					
Temperature, Cycling (−65°C to 200°C) Method 1052 MIL-STD-750	← 24 Cycles →					
Constant Acceleration, Method 2006 MIL-STD-750	← 30,000g →					
Shock, Method 2016 (1.5 msec) MIL-STD-750	← 1,000g →					
Shock, Method 2016 (.5 msec) MIL-STD-750	← 1,500g →					
Shock, Thermal (−65° to 200°C Instant Transfer) 5 cycles — 1 minute dwell	← 5 Cycles →					
Vibration, (100 to 2,000 cps) Method 2056 MIL-STD-750	← 30g →					
Vibration, Fatigue (60 cps) Method 2046 MIL-STD-750	← 20g →					
Hermetic Seal Test (Dye Bomb 100 PSI)	← 24 Hours →					
Lead Tension, Method 2036 MIL-STD-750	10 lbs	10 lbs	10 lbs	—	—	—

NOTE: Glass-Ambient Junction Diodes have exceeded the operating and storage life test conditions of MIL S 19500/116A and MIL S 19500/144:
1,000 hrs Operating Life I_o = 50mA LTPD 10
1,000 hrs Storage Life = 200°C LTPD 10

MICROGLASS diodes are .065" round x .050" long. Leaded versions: silver and nickel leads are .020" round x 1.36" long, ribbon leads are .025" x .003" x 0.70".



World Radio History

MINIATURIZATION AND THE INTERCONNECTION PROBLEM

With the advancement of miniaturization techniques there comes an increasing need for a solution to the interconnection problem. Interconnection devices are now required to be more compact and more reliable and at the same time be easier to maintain. A system which was designed to meet these requirements is fully described here.

By JOHN I. SHUE, JR.
AMP, Incorporated,
Harrisburg, Pa.

MAJOR ADVANCES IN THE MINIATURIZATION of electronic functions demand interconnection systems with very complex capabilities. They are no longer required to simply provide connections, but must support, protect and interconnect complete functions. And, this must be done in the space once occupied by single components. The system described here was designed to accept the responsibility and reliably satisfy the needs of interconnecting today's intricate electronic equipment.

* * *

Interconnections were once made by soldering bulky wires between tin plated copper lugs. This method satisfied the needs of its era; but, with the advance of more complex equipment came the need for a more compact, reliable and easily maintained method of interconnection. These new needs were temporarily satisfied with the advent of printed circuitry which, although it brought new headaches, proved to be a respected and widely used innovation. But, it lived a short period of adequacy in its original form until the transistor and miniature components appeared on the scene accompanied by "miniaturization." This word dominated the industry's every thought and made the interconnection problem one of the toughest challenges in the electronics field today.

Solution to this problem is not a simple one, for miniaturization has not conformed to a "standard" size. Thus, in addition to interconnection's need to take up a minimum of space, it must provide accommodations for various sizes of functions. And, since the innovation of printed circuitry, the interconnection is expected to provide some mechanical support to the electronic function itself. It must also transfer heat from the delicate functions and protect them from hostile environmental effects. A final important requirement is ease of maintainability. Thus, it appears that an interconnection is now an integral part of an overall packaging system.

To fulfill the needs of the system mentioned here and to satisfy industry demands is a task incorporating a knowledge of both electronic and mechanical engineering. A knowledge of materials and a careful study of methods, such as soldering, welding, compression bonding and vacuum deposition, are prime requisites in the development of an ideal system.

The System

AMP Inc. has devised a system to fulfill the needs of the interconnection's role in the electronic industry today.

This system is called MECA*—Maintainable Electronic Component Assembly. Along with its many carefully innovated features, MECA has three major distinctions which were set forward at its conception to be absolute necessities in the design of an interconnection system. These are:

(1) Redundant four point friction contact making the system pluggable down to a function level.

(2) Three dimensional (3-D) circuitry putting a vertical layer of interconnections compactly between the circuit functions making multilayer circuit board almost unnecessary.

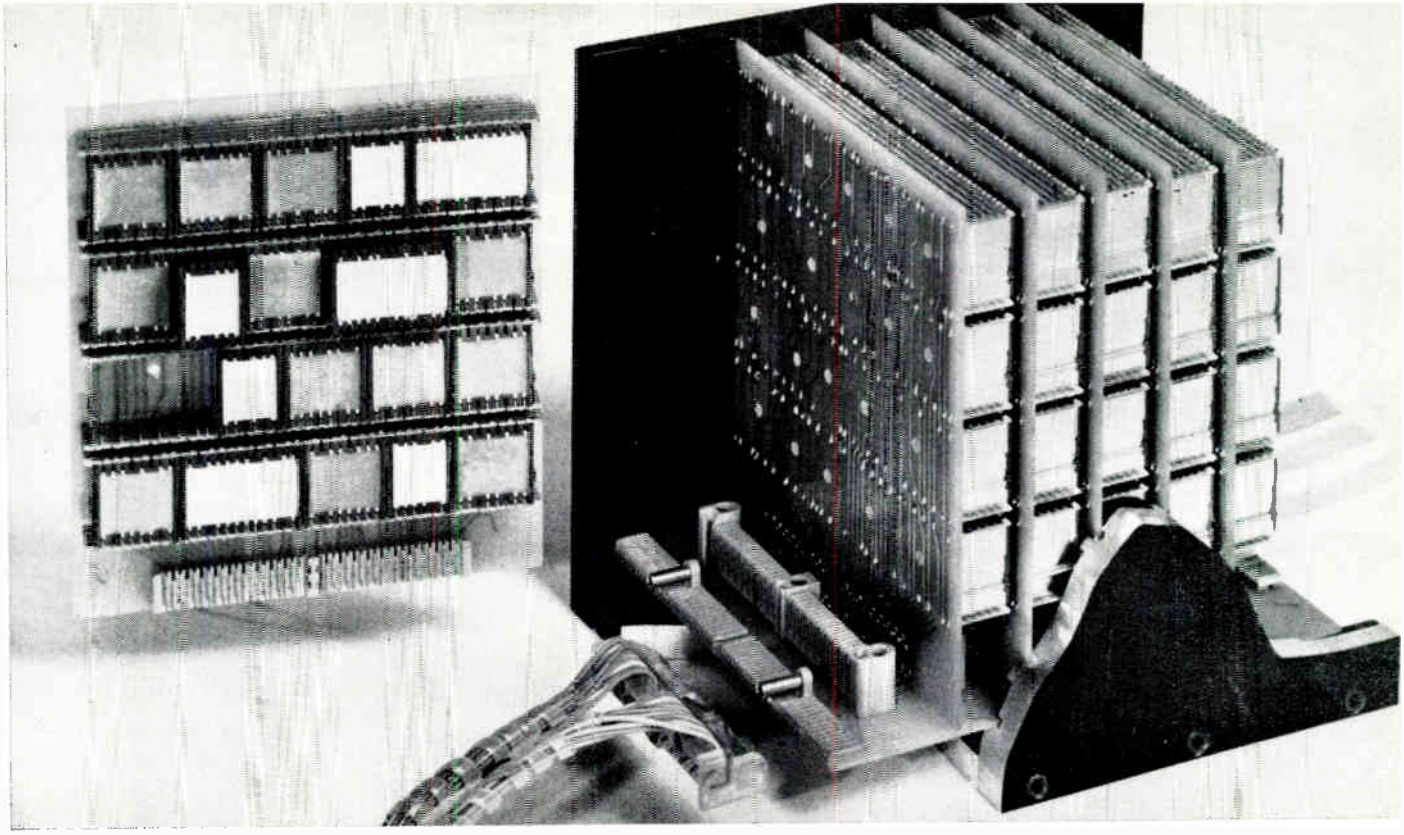
(3) Completely automatable system providing flexibility in a hard wiring system.

A cross section of the industry's trend in the building of electronic equipment indicates

J. I. Shue Jr.

*Trademark of AMP Incorporated.

World Radio History



Assembly (above) consists of six cards of MECA cells joined by connectors (40 position card to card, 28 position wire edge, and 10 position flat cable types). It represents an efficient system with complete pluggability down to the function level.

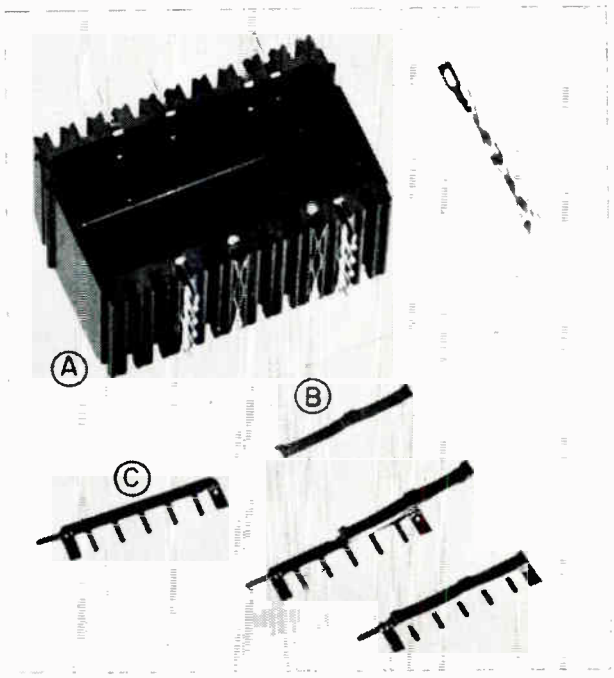
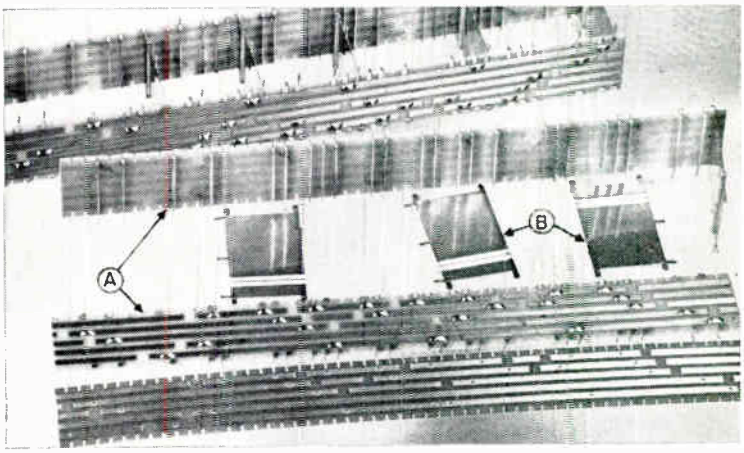


Fig. 1: (a) The MECA cell is made in a variety of sizes. (b) The cell contacts are recessed into the cell walls for protection. (c) The female or rib contact is a flat knife-shaped blade.

Fig. 2: (a) Vertical rows of horizontal conductor paths placed on both sides of MECA cells are called "side rails." (b) Metal spacers are used to assemble each pair of side rails to the base board. This is done by two vertical tines at the bottom.



a move toward plug-in modular type construction.

The MECA cell is made in a variety of sizes and is designed to house and protect these electronic functions. Length, width and height of the cells are expandable. Final size depends upon the number of components representing a function and the number of input-output connections per module. A cell is usually considered a throwaway item. Throwaway modules are generally potted for better heat transfer and to protect sensitive components from damage caused by vibration and shock. The MECA cell acts as its own potting fixture.

The cell contact was designed to give high reliability through redundant points of contact. Potential buyers of packaging and interconnection methods were willing to solder or weld a circuit module directly to a receptacle rather than risk the use of a possibly unreliable contact. With this in mind the cell contact was designed with four distinct parallel paths for current flow. These are obtained through the use of two independent spring systems, each having two points of contact. These contacts are placed on both sides of the cell and recessed into the cell walls for protection. *(Continued on following page)*

World Radio History

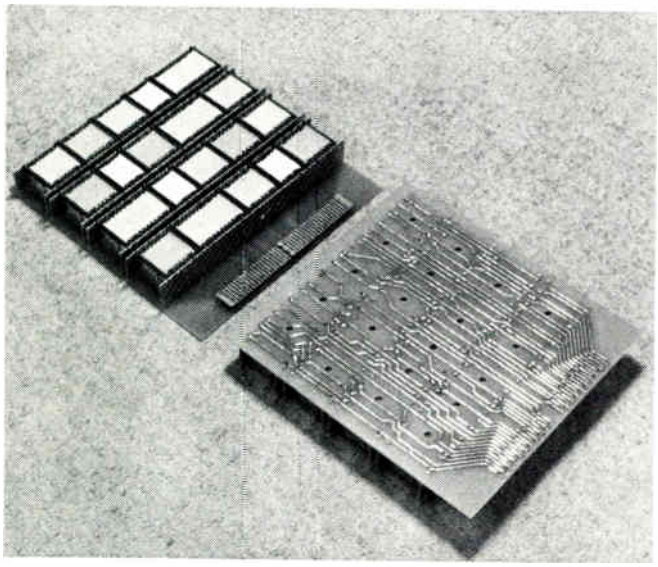


Fig. 3: Completed assembly (above) serves as a receptacle for the cell and also gives mechanical support to the overall system.

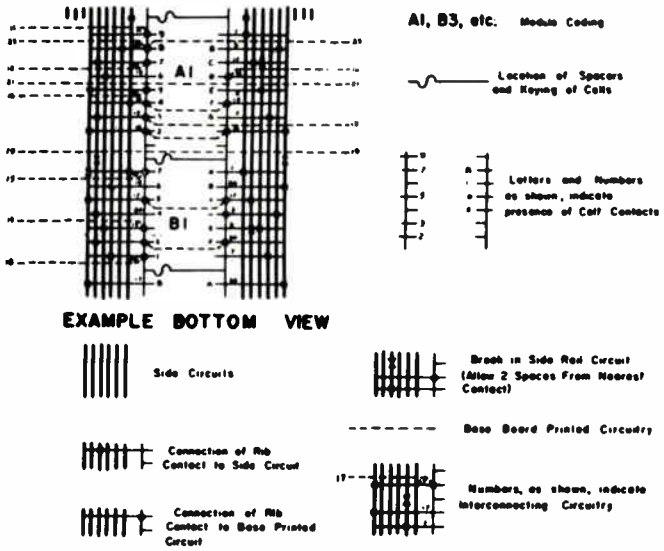


Fig. 4: Layout chart depicts 3-D circuitry in a flat two-dimensional form. Use of this form (see text) cuts engineering time.

World Radio History

The mating counterpart of this female contact is a flat knife-shaped blade referred to as the MECA rib contact. This simple but rugged half of the contact pair is permanently attached to the conductor paths of the interconnection system.

The MECA System easily interconnects complex circuits through use of vertical rows of horizontal conductor paths placed on both sides of the cells and referred to as "side rails." Through use of these "side circuit rails" connections are made between adjacent cells without the use of base board circuitry.

The cell contact is mated to the side rail through the rib contact which is soldered directly to one of the horizontal conductors. A vertical tang at the bottom of the rib contact facilitates interconnections to base board circuitry and thus to other strings of cells. Tabs at top and bottom of the rib contact hold it in place. They do this by protruding through slots in the side rail where they are bent over at right angles opposite to each other. Each pair of side rails is assembled to the base board by use of metal spacers. These spacers attach to the side rails in the same manner as the ribs and are mounted to the base board by two vertical tines at the bottom. In addition to their structural duties, these spacers establish positive keying which prevents improper insertion of the cell. Many times they are grounded to form an electrical shield between modules. The completed assembly forms a box-like structure which serves as a receptacle for the cell and gives mechanical support to the overall system, Fig. 3.

This 3-D circuitry and mechanical structure provides the industry with a system capable of interconnecting very complex electronic circuits. But, a system is not a complete triumph unless it is easy to use and economical to make. These two qualifications are realized in the MECA System because of its incremental grid pattern construction. The cell contacts, rib contacts and side rail circuits are available in 0.050 in. or 0.100 in. grid arrangements and both are suited for automated layout and construction.

Circuit Layout

Layout of circuits to be packaged in the system is done on a specially designed layout chart (Fig. 4) which depicts the 3-D circuitry in a flat, two-dimensional form. The ease with which this form is used cuts engineering time to a fraction of that spent laying out normal multilayer boards. The vertical rows of dark parallel lines represent side rail conductors and the short dashed lines point up the incremental divisions on which the 3-D ribs will be drawn. Two sets of these parallel dark lines with the incremental divisions between them represent a one string MECA assembly.

The first step in the use of this chart is to determine the size of each cell and show its length by drawing a spacer in the position corresponding to the cell length. In addition to the spacer designations, numbers are placed at the incremental divisions to represent location of cell contacts.

In making interconnections between cells, horizontal lines are drawn across the parallel vertical lines. These are drawn in positions corresponding to the cell contacts that will be connected. These lines represent the rib contacts. Dots are then placed at the intersection of the rib lines and a vertical "side conductor" line, thus completing the circuit between cells. A dot positioned on the incremental division mark and joined by a dashed line indicates connection of the rib to the base board. Base board circuitry to external connectors or other strings of cells is indicated by these dashed lines. It can be seen that all base board circuitry runs horizontally across the chart with no crossovers. All crossover connections are done on the side rails thus eliminating need for multilayer base boards.

Logic interconnections may consume short portions of the side rail. This makes it possible to cut the conductor and use the remaining portion for other circuits. A "break" in the side rail is indicated by placing an "X" on the layout chart where interruptions will occur. (See example on Fig. 4.)

At this point the electrical and mechanical engineering is complete. Ordering parts is made easy by the grid system structure. Each dot and break on the layout chart has a specific numerical location; thus, to order his custom side rail the engineer needs only to tabulate these positions and forward the tabulation to AMP where they are automatically built. Assembled side rails and cells with contacts are sent to the customer who completes the package by soldering the side rail assembly to the base board and inserting the components into the cells.

Attachment of components to cell contacts is done in various ways depending upon what type circuitry is used and whether soldering or welding methods are preferred. It is, of course, desirable to automate the building of 3-D modules if possible, and a method has been devised to do so.

Automated Procedure

The automated procedure (Fig. 5) uses methods common to printed circuit (P.C.) construction and needs no additional equipment or methods beyond those used in flat board fabrication. The P.C. board used is 1/32 in. thick. It is really two small chip boards held in proper orientation by a small section which, after component insertion, is removed. Components and wire jumpers are mounted on the board by automatic insertion machines and the boards are folded into a 3-D form. This module is then dropped into a MECA cell with the contact tabs protruding through holes in the P.C. board after which the tabs are bent over and flow soldered. The top board extends over the sides of the cell to act as a handle for withdrawal of the module from its receptacle.

Module Size

The module just described is most commonly used in 0.100 grid MECA. But, the appearance of inte-

World Radio History

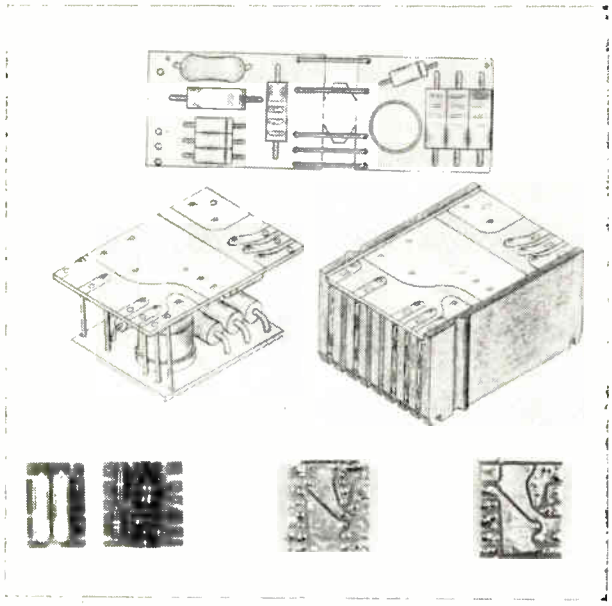


Fig. 5: Automated procedure which is described in the text.

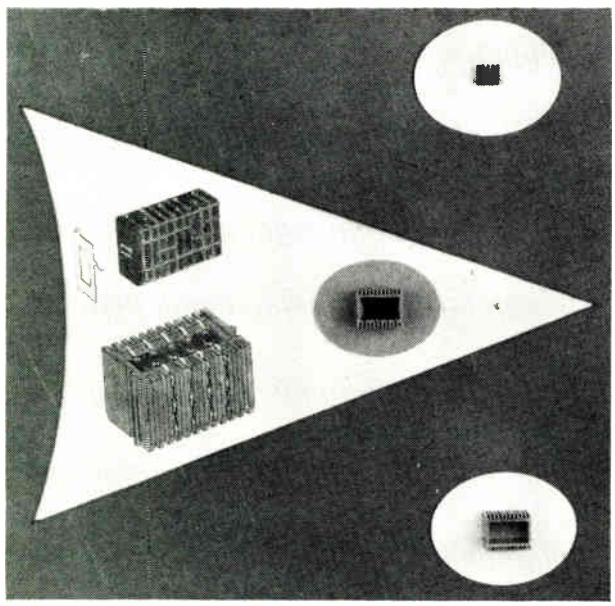
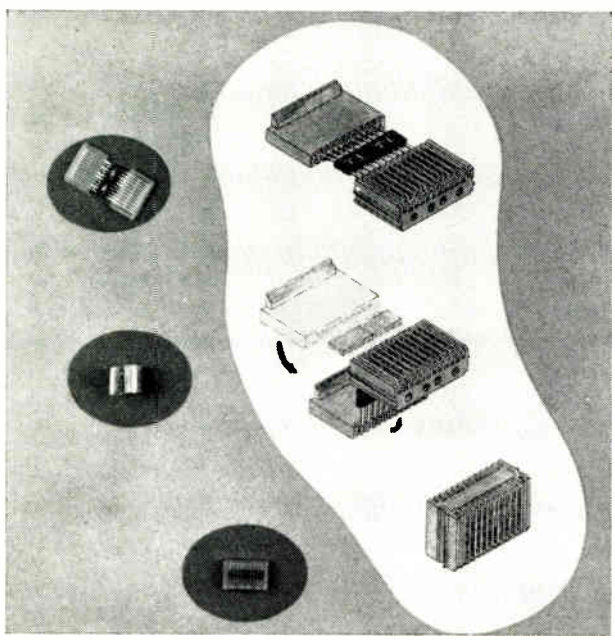


Fig. 6: Example of component attachment in small grid system.

Fig. 7: Two-wafer plug-in package is reasonably priced.



INTERCONNECTION PROBLEM (Concluded)

grated circuits and other miniature components necessitated provision of more input-output possibilities and the 0.050 grid system was developed. Fig. 6 shows an example of component attachment in the small grid system. The Texas Instrument integrated circuit wafers are grouped in a package of ten (or less) and flat leads welded between wafers form a small rectangular module. Interconnectors (Fig. 6) made by TI bring the leads to the top of the module where they are welded to tabs on the cell contact.

Price plays an important role in determining the size of a throwaway module. Hence, a two-wafer package is shown in Fig. 7 which represents a more reasonably priced plug-in assembly. The cell in this assembly is molded in two halves. In attaching the wafer leads to the contacts, both halves of the cell and the two wafers are placed in a jig and the overlapping leads are welded. The cell halves are then folded and cemented together forming a completely closed unit. Encapsulation is done through holes in the bottom of the cell.

In order to complete the system a line of connectors was developed using the same four point contact used in the MECA cell. These connectors, made on 0.050 in. and 0.075 in. spacing, provide reliable connections to flat cable, wire harness and P.C. cards. The assembly (photo on opening spread) consists of six cards of cells integrally joined by the above connectors representing an efficient system with complete pluggability down to the function level.

The Future

New methods in the fabrication of electronic components will place unpredicted demands upon interconnecting devices. Miniature contacts, as we know them now, will soon be considered bulky and inadequate, and the space they occupy will some day enclose complete electronic functions. This means that multiple input-output connections will be necessary in the area once consumed by a single contact. These interconnections, along with the circuit components, can conceivably be deposited on one large integrated unit, thus eliminating the contact as an interconnection between functions. But, components will continue to fail, making trouble-shooting and maintainability a must. Maintenance will be done by substitution of sub-units and the size of this throwaway function will be determined by cost. A guess would estimate the price of this item as about $100, the size to be half that of a postage stamp. The number of external connections will vary between 50 and 100 leads. Therein lies an interconnection challenge.

AMP's approach to this problem will use methods found in the manufacture of circuit elements themselves, since an interconnection system compatible with modern components must be made through comparable methods if reliable and effective miniaturization is to prevail.

World Radio History

RCA Vidicons for every TV application

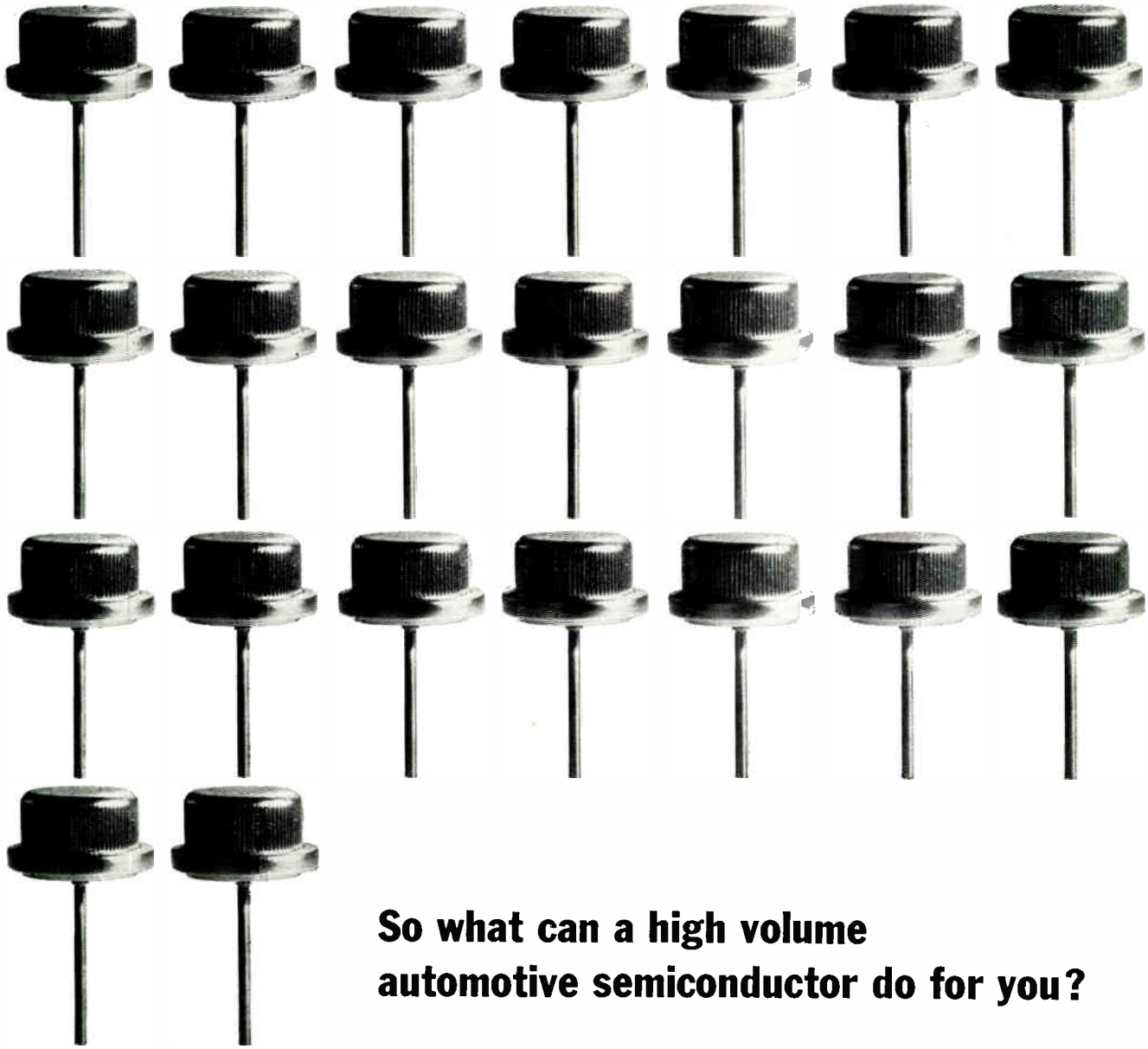
You get the widest choice of types in RCA's line of vidicons—the industry's broadest. There's a size, sensitivity, and range of electrical characteristics to meet your black-and-white and color pickup requirements . . . in off-the-shelf types and special custom designs. Check with your RCA Representative about the RCA Vidicon line. For information on specific types, write: Commercial Engineering, Section 1-50-Q, RCA Electronic Components and Devices, Harrison, N. J. For special requirements, contact: Manager, Camera Tube Marketing, RCA, Lancaster, Pennsylvania.

INDUSTRIAL 7262A 7735A 8134 8507	**ENTERTAINMENT** 7038 8134 8480 8507 7735A	**EDUCATIONAL** 7735A 7038
OUTER SPACE Manned Exploration LEM/APOLLO C74098	**OUTER SPACE** Remote Picture Transmission TIROS C73496 RANGER C74072	**INNER SPACE** Oceanographic Surveys 7735A 8134 7263A
SCIENTIFIC Accelerator Surveillance 7735A	**ASTRONOMICAL** Star Tracker C73496 C74016	**DATA TRANSMISSION** Character Reader C74129 8521
HEAT DETECTION Infrared C74125	**X-RADIATION DETECTION** X-Radiation 7262A	**BIOLOGICAL RESEARCH** Ultraviolet C73439

RCA®

The Most Trusted Name in Electronics

World Radio History



So what can a high volume automotive semiconductor do for you?

Save you money, for one thing.

Consider Delco Radio's press fit and stud base rectifiers.

They're designed and built for rugged automotive applications, where devices don't stick around long unless they're especially reliable—(successful operation for several billion device hours insure this)—and they don't get used at all unless their price is low.

The 18-ampere 1N3491-93 press fit series in 50, 100 and 200 P.R.V. ratings will withstand current surges to 300 amperes. Hermetic sealing and extensive thermal cycling assure stability of operation from —65°C to +175°C—for as low as two cents an amp.

For stud mounting, the same basic rectifier is available in the 15-ampere 1N3208-12 series with stud package. They will maintain full-rated peak reverse voltages of 50, 100 or 200 volts to +175°C which extends through the forward current derating range of 150°C to 175°C.

Or maybe you'd be interested in other rectifiers being readied for high volume applications such as: the new 750 ma, 50- or 100-volt silicon encapsulated DRS 100 series, the DRS 150 series of 1.5 ampere "top hats," or the heavy-duty 800 to 1200-volt, 250-ampere DRS-250 series.

For the full story on delivery, price and reliability advantages these high volume devices can offer you, contact any Delco Radio sales office. They'll supply you with data, prices and applications assistance.

*Union, New Jersey
324 Chestnut St.
MUrdock 7-3770
AREA CODE 201

Detroit, Michigan
57 Harper Ave.
TRinity 3-6560
AREA CODE 313

Palo Alto, California
201 Town & Country Village
DAvenport 6-0365
AREA CODE 415

*Santa Monica, Cal.
726 Santa Monica Blvd.
UPton 0-8807
AREA CODE 213

Syracuse, N.Y.
1054 James St.
GRanite 2-2668
AREA CODE 315

*Chicago, Illinois
5151 N. Harlem Ave.
775-5411
AREA CODE 312

DELCO RADIO
DIVISION OF GENERAL MOTORS, KOKOMO, INDIANA

*Office includes field lab and resident engineer for applications assistance. General Sales Office: 700 E. Firmin, Kokomo, Ind., Gladstone 2-8211—Ext. 500 • Area Code 317

Circle 29 on Inquiry Card →
World Radio History

NEW! A FULL LINE OF ACCURATE, RELIABLE, EASY-TO-USE

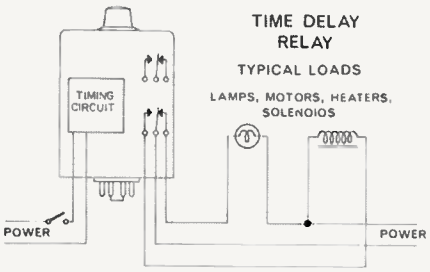
SOLID STATE time delay relays

A wide range of time delay needs can be met with these high quality, CD Series solid state relays. Time delays range from 0.1 to 300 sec. Reset is milliseconds fast. Output contacts vary from solid state Form A to mechanical DPDT relay internally mounted or 4PDT external relay.

Solid state units may be used also to switch lamp, solenoid or other loads. AC or DC models are available.

EASY TO APPLY IN ANY CIRCUIT

P&B solid state time delay relays fit into circuits as easily as other reliable electronic components. Timing is repeatable



to ±2%. Delays may be obtained on operate or, when specified, on release. Choose from knob-adjustable, resistor-adjustable or fixed time delay relays.

ADVANTAGES OF SOLID STATE TIME DELAYS

These relays reset in milliseconds . . . no waiting for thermal elements to cool. No heating problems, either. CD Series solid state time delays are engineered to match the performance of many quality P&B relays. As illustrated below, these units form matched pairs: CD-45/PR relay, CD-21/KRP relay, CD-31/KHP relay.

TYPICAL APPLICATIONS

Machine tool controls	Data processing
Elevator controls	Plastics molding
Conveyor controls	Chemical processing
Induction heating	Container filling

MAKE YOUR CHOICE FROM A BROAD LINE

Many shapes and sizes of time delay relays are available . . . the CD-31, for example, is only slightly larger than one cubic inch. Load switching can be either AC or DC ranging up to 25 amperes at 115V AC, non-inductive or 1 HP at 115/230V AC, single-phase.

THESE STANDARD TIME DELAY RELAYS ARE AVAILABLE FROM ELECTRONIC PARTS DISTRIBUTORS

Type	Time Delay in Seconds	Input Voltage	Notes	Sugg. List Price
CDB-38-70003	0.1 to 10	115V AC	1	43.80
CDB-38-70005	1.8 to 180	115V AC	1	43.80
CDD-38-30003	0.1 to 10	24V DC	1	41.55
CDD-38-30005	1.8 to 180	24V DC	1	41.55
CDB-21-70003	0.1 to 10	115V AC	2	38.70
CDB-21-70001	1.8 to 180	115V AC	2	38.70
CDD-21-30003	0.1 to 10	24V DC	3	38.35
CDD-21-30001	1.8 to 180	24V DC	3	38.35
CDH-31-30005	180 (note 5)	24V DC	4 & 5	38.90

NOTES

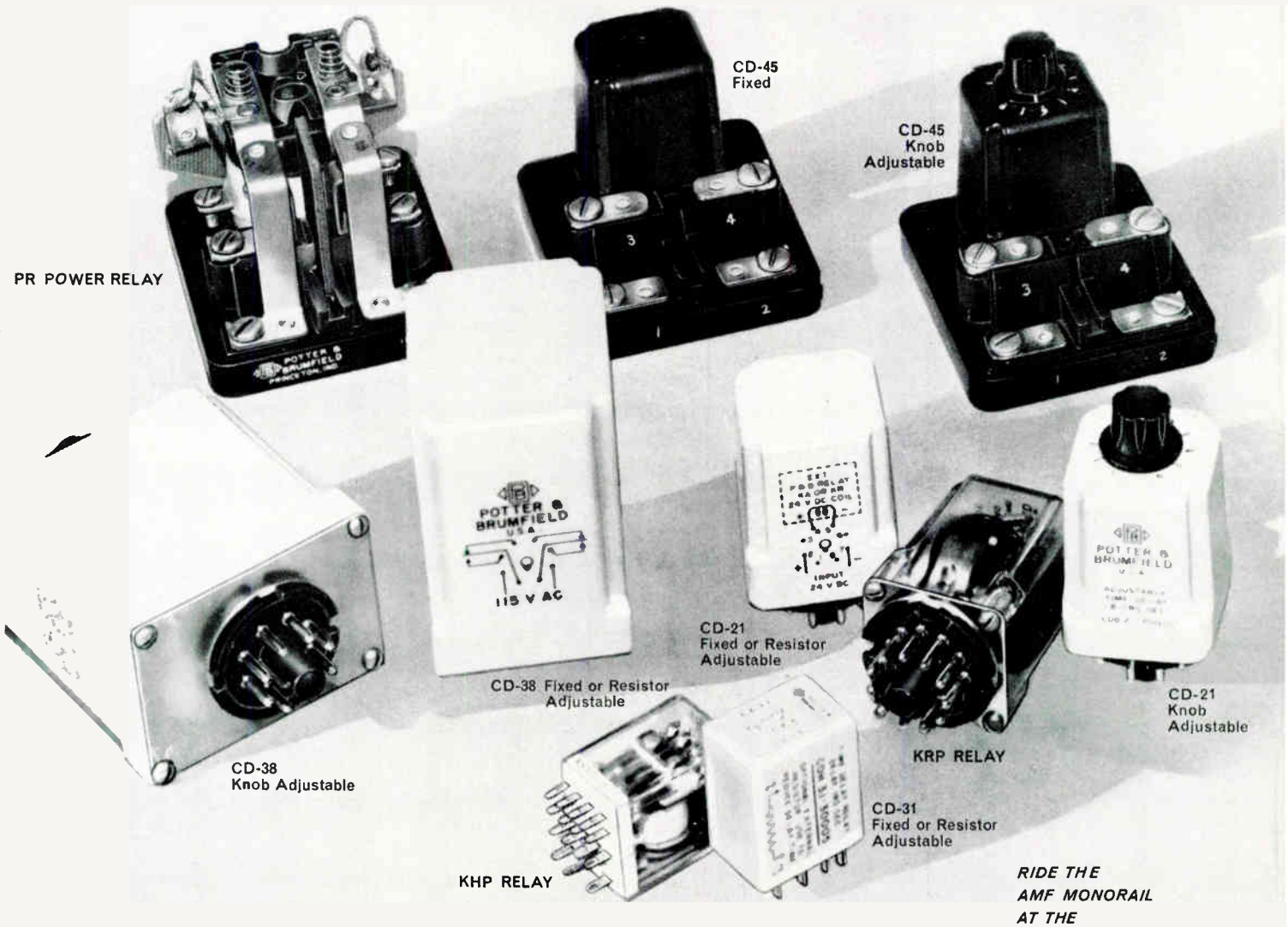
1. Has internal relay with DPDT contacts rated at 10 amperes, 115V AC.
2. Use with Potter & Brumfield relay KRP11AG—115V AC or KRP14AG—115V AC.
3. Use with Potter & Brumfield KRP5DG—24V DC, KRP11DG—24V DC or KRP14DG—24V DC relay.
4. Use with Potter & Brumfield KHP17D11—24V DC relay.
5. Resistor-adjustable.

Call today for complete information.

POTTER & BRUMFIELD

Division of American Machine & Foundry Company, Princeton, Indiana

In Canada: Potter & Brumfield, Division of AMF Canada Ltd., Guelph, Ont.



RIDE THE AMF MONORAIL AT THE NEW YORK WORLD'S FAIR

World Radio History

Read to 1/1000 Turn Accuracy

With New Spectrol Dials for Potentiometers and Other Rotating Devices

Model 11 * diameter 1" * number of turns 11 * protrusion from panel 7/8" * numbers snap into the window as each turn is completed * base price in 1-9 quantities, $7.75.

Model 30 * diameter 1 13/16" * number of turns 10 * protrusion from panel 1" * numbers snap into the window as each turn is completed * base price in 1-9 quantities, $5.75.

Model 25 A new turns-counting dial with DIGITAL readout for multi-turn applications * 3-digit dial reads to 1099 (11 turns) * 4-digit dial reads to 9999 (100 turns) * fine calibrations allow setting to 1/1000 of a shaft turn * 2 to 1 gear ratio between setting knob and device shaft allows extremely fine settings * diameter 1 13/16" * standard 11-turn, 3-digit dial price, 1-9 quantities, $14.25 * standard 100-turn, 4-digit dial price, 1-9 quantities, $19.75.

Spectrol Multidial® turns-counting dials offer these unique features: **Finely marked scale graduations** enable the operator to read settings with high accuracy. **Easy installation.** No disassembly, extra panel drilling or mounting hardware required. **Easy locking** with a finger touch that grips or releases without disturbing the setting. Settings are unaffected by vibration or shock. **Universal application** to any type of multi-turn potentiometer or other device. **Attractive satin chrome finish** with black plastic turning knob. Available for 1/4", 3/16" and 1/8" diameter shafts.

Call your nearest Spectrol distributor for immediate off-the-shelf delivery at factory prices, or write for complete specifications.

SPECTROL ELECTRONICS CORPORATION

1704 South Del Mar Avenue
San Gabriel,
California

Adams Court
Plainview, L. I.
New York

P.O. Box 130
Brampton
Ontario

Circle 30 on Inquiry Card

World Radio History

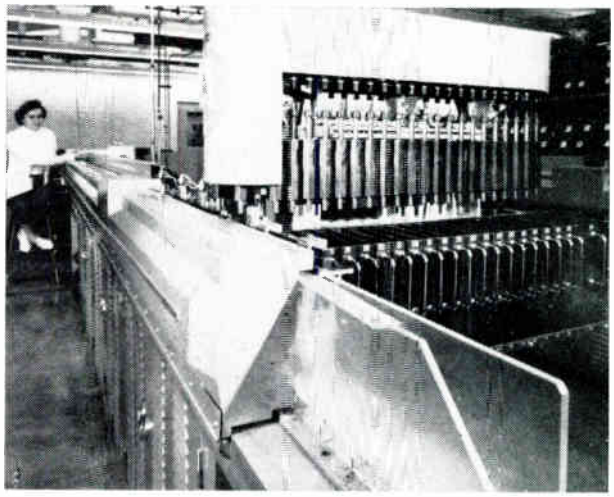
COMPUTER-CONTROLLED TRANSISTOR TEST LINE

THE MOTOROLA COMPUTER-CONTROLLED TRANSISTOR TEST LINE (M-3600) evaluates up to 40 parameters of transistor performance, and compares the test profile with 40 preselected specification profiles.

A readout provides a tally of transistors sorted into each category, plus data showing why the transistor is not meeting specifications.

Here's how the system works. Transistors are automatically loaded into plastic carrier boards which are then placed on a track. This track carries them past the test stations. Each transistor is indexed over 40 test sockets, and moved on to the next position until they reach the unloader and sorter. At each test position a solid-state module applies the test condition for each parameter, and also converts the test result into a proportional dc output voltage. Each module's output is fed to a comparator which compares the signal with spec. values.

As the device completes its tests, the computer compares all the test results with the pre-programmed specs. and determines the highest priority spec. the device will satisfy. The computer then signals the sorting mechanism which drops the transistor into the proper bin.



Line requires one operator and performs 40 profile checks.

The test line is marketed by Kulicke and Soffa Mfg. Co., 135 Commerce Dr., Industrial Park, Fort Washington, Pa.

MINIATURE TRANSMITTER SPANS CONTINENT

A CONTINENT-SPANNING RADIO TRANSMITTER that uses body heat for frequency control and fits in a shirt pocket has been developed by RCA, Tucson, Ariz.

The transmitter weighs 10 oz., including batteries, and operates on any frequency between 2 and 30MC. The unit is rated at 100 mw.

In operation, the user places a miniature metal container, linked to the transmitter and containing frequency-determining crystal elements, under his upper arm. Here, a high degree of temperature stability exists which is vital to frequency control. Success of the long-range transmission concept is based on using the stable high-frequency skywave medium for an extremely narrow bandwidth reception. The concept follows the simple rule that if the receiver bandwidth is reduced to one-half on a given transmission path, the required transmitter power can be halved and a smaller transmitter used.

The transmitter, which is designed for emergency uses such as downed pilots, requires a special receiver. This receiver weighs 40 lbs. and operates on the same frequencies as the transmitter.

Miniature transmitter has a 1 oz. antenna and a 100mw output. It can transmit signals across the United States.

(More What's New on Page 77)

World Radio History

Armco Steels/for electrical and electronic apparatus

Make cores lighter and smaller, use less copper, reduce losses with Armco Thin Electrical Steels

Armco Thin Electrical Steels offer you these advantages because their unique combination of exceptional magnetic and physical properties is assured by precise processing and control:

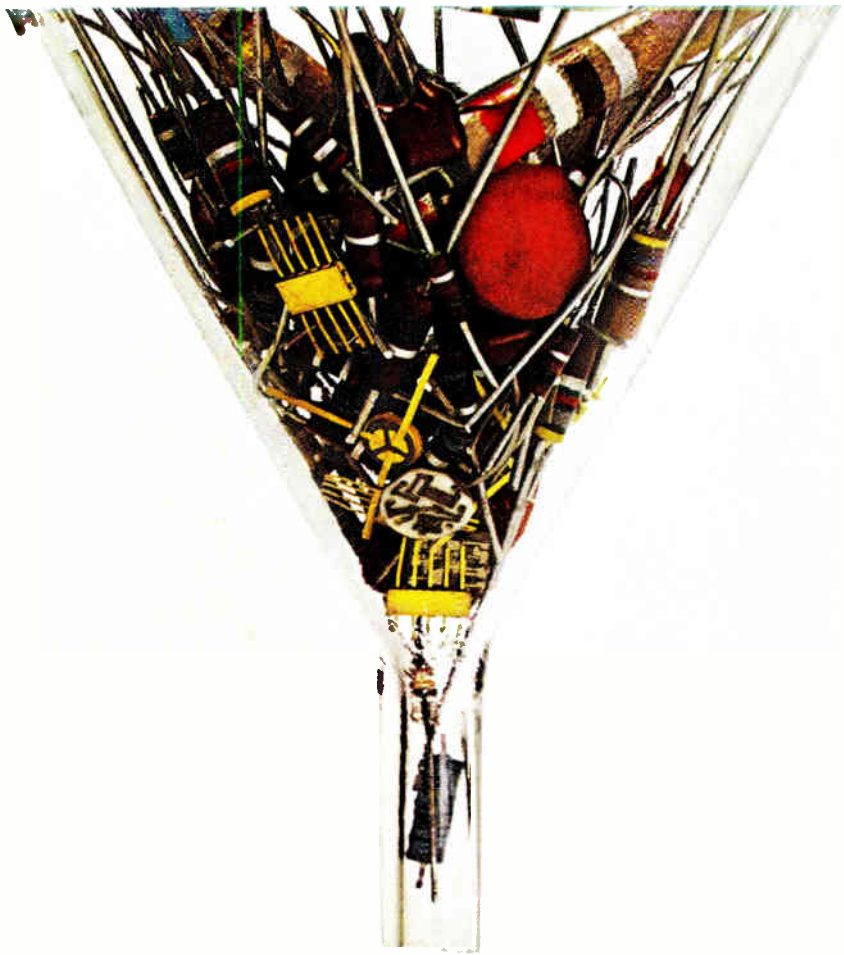
- **Exceptionally high permeability**
- **Low hysteresis loss**
- **High lamination factor**
- **Minimum interlaminar loss**
- **Properties fully developed at the mill**

To enable you to design most effectively, Armco Thin Electrical Steels are produced in three different grades and a wide range of thicknesses. Armco TRAN-COR® T, a nonoriented grade, is available in 7 and 5 mil thicknesses; Armco ORIENTED T in 1 to 6 mils; and Armco ORIENTED TS, a super-oriented grade with exceptionally high permeability, in 4 mil thickness.

Improve performance and reduce both size and cost of 400 to 2000 and higher frequency components with these special Armco Electrical Steels. A new edition of our design manual is available to help you utilize their advantages most effectively. Write for your copy. **Armco Division, Armco Steel Corporation, Dept. A-3394, P. O. Box 600, Middletown, Ohio 45042.**

ARMCO **Armco Division**

World Radio History



Now put all these into a space

Or, better yet, let us do it for you.

Amphenol systems packaging experts can rescue you from the thousand-and-one details, coordination of many suppliers, the ultimate and sticky responsibility for every stage of your system. And we can probably do it for less money and with better results than if you did it yourself.

Here's how we can help:

1. We've already helped others—in computers, aircraft, missiles, semiconductors, communications, instrumentation, controls . . . and more.

2. We are constantly handling a great variety of packaging and interconnection problems. We own virtually every kind of equipment that we (or you) might need.

3. So our engineers are not limited to any one approach. If you have to lower costs, we'll find a way to do it; if you are raising the ceiling on reliability or trying to achieve the ultimate in miniaturization, you couldn't be talking to a more savvy systems group.

4. Our men are packaging experts, familiar with the most up-to-date materials, methods, and processes as well as the old standbys.

The result? Integrated systems.

Every connection from the diode leads, through the module, the motherboard, the back panel—the complete system—is made to "play on the team." Each level of the system performs according to the original rules you set.

So talk to the man from Amphenol Microelectronics. Jack Rolf is his name. Just phone 312-345-9000. If Jack's line is busy (it often is), ask for Steve Zelencik or Lee Eichenseer.

Amphenol®

A DIVISION OF AMPHENOL-BORG ELECTRONICS CORPORATION

World Radio History

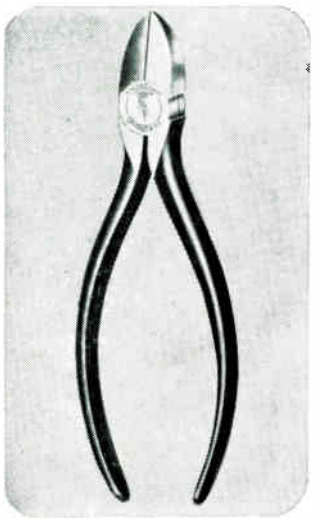
KLEIN PLIERS *Speed up electronic wiring*

When the crystal set was a seven-day wonder, Klein long nose pliers were used to adjust the cat's whisker. Through the era of B and C battery sets, Klein kept pace by providing pliers specially adapted for electronic wiring.

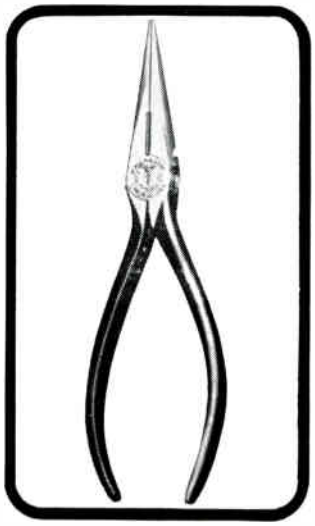
Today, more than 100 different styles and sizes of Klein pliers are available to provide the exact tools needed for any job. Klein engineers have developed a special plier for wiring printed circuits; a high hardness plier for cutting nickel ribbon wire; a transverse end cutting plier for cutting closely in confined spaces; extremely small pliers for wiring midget assemblies—and many others.

Klein has also developed special pliers to do special jobs requested by electronic manufacturers.

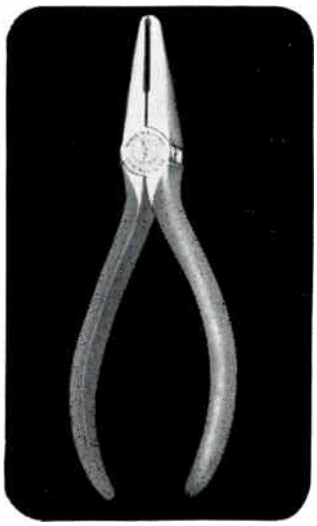
For better work done more quickly and at lower cost, be sure the pliers you use are exactly suited to the job . . . made by Klein, of course, "Since 1857."



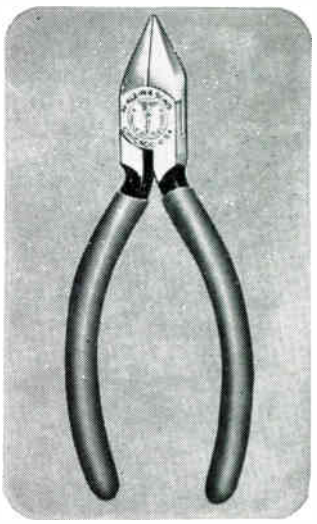
202-5C Oblique Cutting Plier with narrow nose. Available with coil spring. 5½-, and 6-in. sizes.



203-5C Long Nose Side Cutting Plier. Available in 5½-, 6½- and 7-in. sizes. Supplied with coil spring.

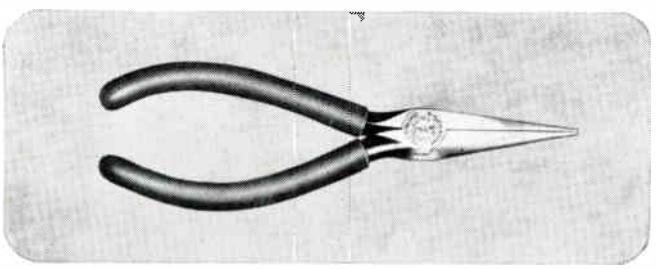


204-6C Transverse End Cutting Plier, 6-in. long. Supplied with coil spring to hold jaws open.

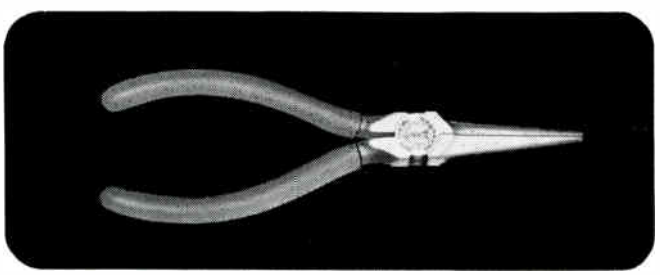


D209-5C Lightweight, Pointed Nose, Flush Cutting Plier. Supplied with coil spring to hold jaws open.

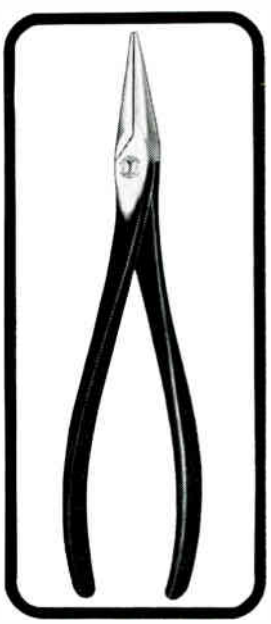
301-5C Long Nose Plier. Available in 5½-, 6½- and 7-in. lengths. Coil spring.



D307-5½C Slim Long Nose Plier for reaching into confined spaces. Yellow plastisol handles. Supplied with coil spring to hold jaws open.



D310-6C Slim Long Nose Plier. Handles are yellow plastisol covered. Supplied with coil spring to keep jaws open.



314-8 8-in. Long Nose Plier. Jaws have knurl.

Mathias Established 1857 **KLEIN** & Sons Chicago, Ill., U.S.A.
INCORPORATED
7200 McCORMICK ROAD, CHICAGO 45, ILL.

See Your Distributor

Foreign Distributor: ITT Export Corporation, New York

World Radio History

DALE

RELIABILITY

TOTAL CAPABILITY IN PRECISION RESISTANCE

To get the best METAL FILM deal...

(Dale is competitive... and a better buy besides)

Price should be the least of your worries. Right now, several metal film manufacturers (including Dale) are offering MIL-R-10509 RN parts in a price range which is more competitive than ever before.

But price doesn't equalize quality. Neither does it assure you of the delivery you need. Or the part-to-part homogeneity that can turn a good price into an outstanding one because of the overall savings it makes possible.

You can get these quality, delivery and homogeneity assurances – at a competitive price – by dealing with Dale. Continued expansion utilizing the most advanced automated equipment plus long-established systems of value analysis enable us to be fiercely competitive – without sacrificing quality standards. Standards which enable Dale MF, MFF and MFH resistors to go *beyond* the Mil. Spec. in meeting your needs.

Delivery? Right now, we're meeting 2-week delivery dates on orders for 50,000 parts in ½-watt size.

Don't be bashful about asking us to prove all this. We're continually developing good metal film customers who, at first, were surprised to find we were in the business. As a matter of fact, we'll be pleased to show you that there's still a lot more to a metal film resistor than price.

DALE ELECTRONICS, INC.

1304 28th Avenue, Columbus, Nebraska

For more information circle No. 98.

Turn page for METAL FILM CHECK LIST

DALE METAL FILM CHECK LIST

When specifying metal film resistors look for these features at a competitive price—

DALE has them!

MFF Epoxy coated. Meets electrical and environmental requirements of Char. B, C, D, E; MIL-R-10509E, but is dimensionally smaller.

MFH Hermetically sealed in ceramic tube. Meets requirement G; MIL-R-10509E.

MF Transfer molded in epoxy. Meets all requirements of Char. B, C, D, E, F, MIL-R-10509E.

☐ LOW NOISE CONSTRUCTION

Dale Metal Film Resistors have exceptionally low noise level. Maximum for standard resistance range is 0.10 micro-volt per volt over a decade of frequency, with low and intermediate values below 0.05 micro-volt per volt. Oxides commonly formed in methods using gold or silver terminating bands are a definite factor in creating noise and instability. To obtain low noise levels, Dale uses a unique production method in which a terminating band of low-resistance metal alloy is deposited in the same vacuum as the metal film element. This results in a uniform, *OXIDE-FREE*, low noise contact area between film, band and press-fit cap.

☐ CONTROLLED TEMPERATURE COEFFICIENT

In the operating temperature range of −55° C to +175° C, Dale Metal Film Resistors are available in 10 standard T.C. Codes from 0±150 ppm/° C to 0±25 ppm/° C. Close T.C. matching between pairs or sets is also available.

☐ GOOD HIGH FREQUENCY CHARACTERISTICS

Low reactance is standard with Dale Metal Film Resistors and results in excellent stability at high frequencies. For extremely critical applications above 100 megacycles, non-helixed or laterally-adjusted units can be supplied.

☐ ABILITY TO MEET SPECIAL REQUIREMENTS

At your request, Dale can readily supply:

- Terminals in any commercial material with several type finishes.
- Special pre-conditioning (power aging, temperature cycling, etc.) to your specifications.
- Close tolerance matching in pairs or sets.
- Resistor networks packaged in various configurations and encapsulants.

☐ MAXIMUM FLEXIBILITY IN ENVIRONMENTAL PROTECTION

To insure product homogeneity and optimum performance, Dale has developed its own coating and molding material formulations. The superior performance of these materials has been demonstrated in comparative tests which show the Dale MF resistor to be the most moisture-resistant molded unit available. Three types of protective coatings are offered to give maximum flexibility of choice: • Conformal coated MFF resistors • Transfer molded MF resistors and • Hermetically sealed MFH resistors.

GENERAL SPECIFICATIONS—TYPE MF*

DALE TYPE	MIL TYPE	125° C RATING	RESISTANCE RANGE	DIMENSIONS (L. × D.)
MF-50	RN-50 (Proposed)	1/20 watt	49.9 ohms to 60K ohms	.140×.065
MF-1/10	RN-55	1/10 watt	49.9 ohms to 200K ohms	.250×.093
MF-1/8	RN-60	1/8 watt	30 ohms to 550K ohms	.406×.140
MF-1/4	RN-65	1/4 watt	30 ohms to 1 Megohm	.593×.203
MFS-1/2	RN-70	1/2 watt	49.9 ohms to 2 Megohms	.750×.250
MF-1	RN-75	1 watt	49.9 ohms to 6 Megohms	1.093×.375
MF-2	NA	2 watts	100 ohms to 15 Megohms	2.188×.375

Tolerance: ±1% standard; ±.5%, ±.25%, ±.1% available.

ENVIRONMENTAL SPECIFICATIONS*

Dale MF resistors are manufactured to the environmental specifications of MIL-R-10509E. Characteristics D, C or E apply depending on T.C. Code specified at purchase.

DALE T.C. CODE	APPLICABLE CHAR. OF MIL-R-10509E
T-1 (100 P.P.M./°C)	D
T-2 (50 P.P.M./°C)	C
T-9 (25 P.P.M./°C)	E

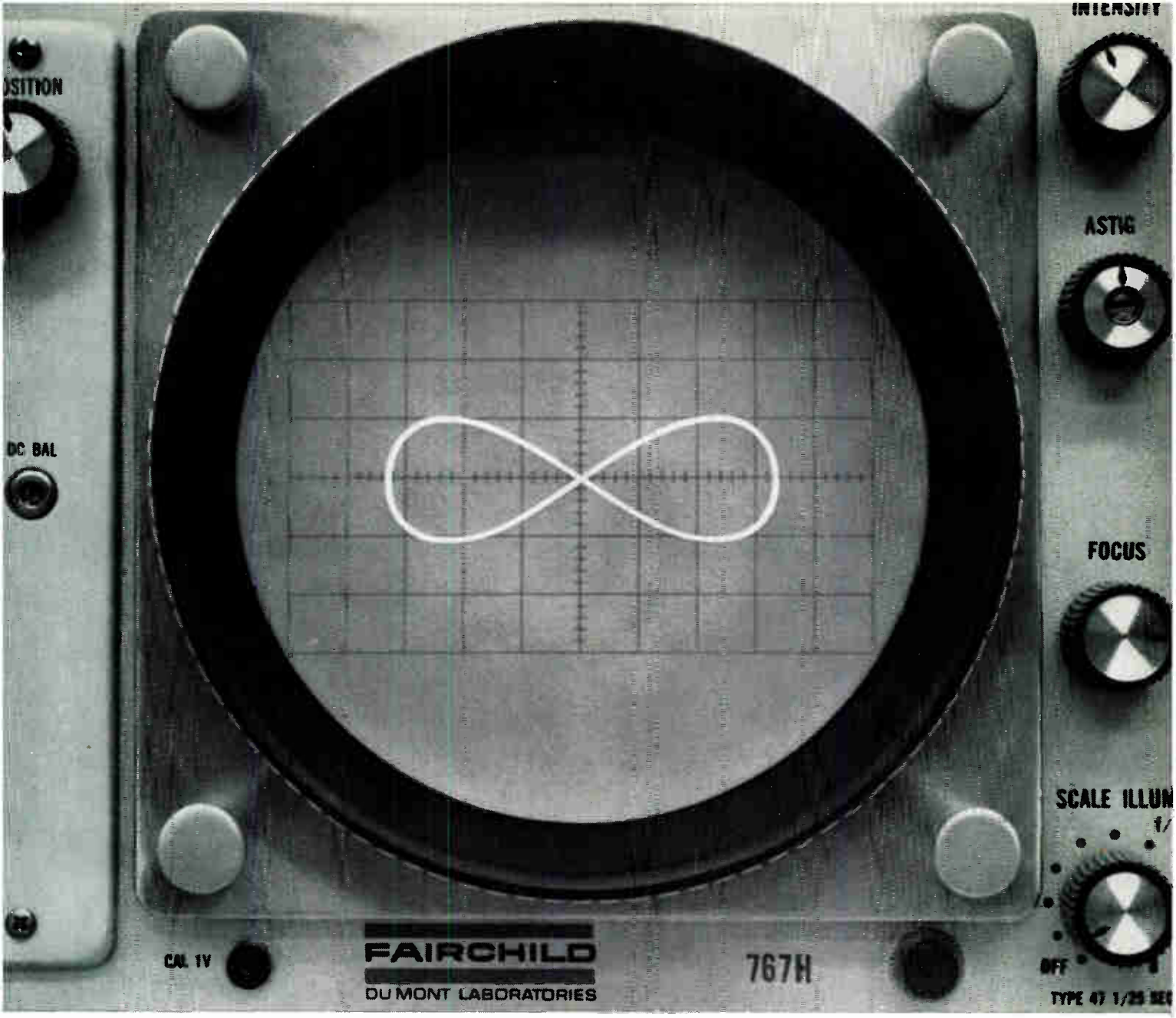
*Specifications for MFF and MFH are similar, but vary dimensionally.

NEW CATALOG An all-new version of Catalog A, giving comprehensive information on Dale's complete Film and Wirewound Resistor line is now available.

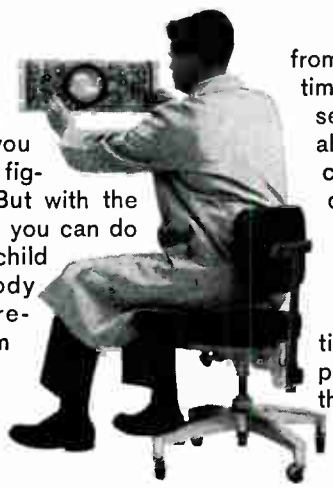
NEW FILM STRIP Confused about reliability and quality control claims? Dale has a new film strip explaining how these systems work. Ask your Dale Representative, or write factory to arrange for a showing.

DALE ELECTRONICS, INC.
1304 28th Avenue, Columbus, Nebraska
Also Made and Sold by Dale Electronics Canada, Ltd., Toronto, Ontario, Canada

VSMF



Versatility Almost Unlimited



The capabilities of Fairchild's solid-state Series 765H scopes aren't quite infinite (although you can set up this Lissajous figure for fun or profit). But with the many plug-ins available, you can do more with a single Fairchild scope than with anybody else's. For example, frequency may range from DC to 100 mc (3 db down), sweep rates from 5 nsec/cm to 1 minute, rise-times to 3.5 nsec. All Fairchild 765 series plug-ins are interchangeable; among other things, you can get single or multiple X-Y displays by using identical plug-ins in both compartments simultaneously. The main frame of the new 765H series is available in three configurations: bench, rack, and the compact Portascope®. There is also the militarized Portascope. Versatility? Almost unlimited. For more information, write for the Fairchild Instrument Catalog, or ask a field engineering office for a demonstration; there's one in your area. Fairchild Scientific Instrument Dept., Section 94, 750 Bloomfield Ave., Clifton, N. J.

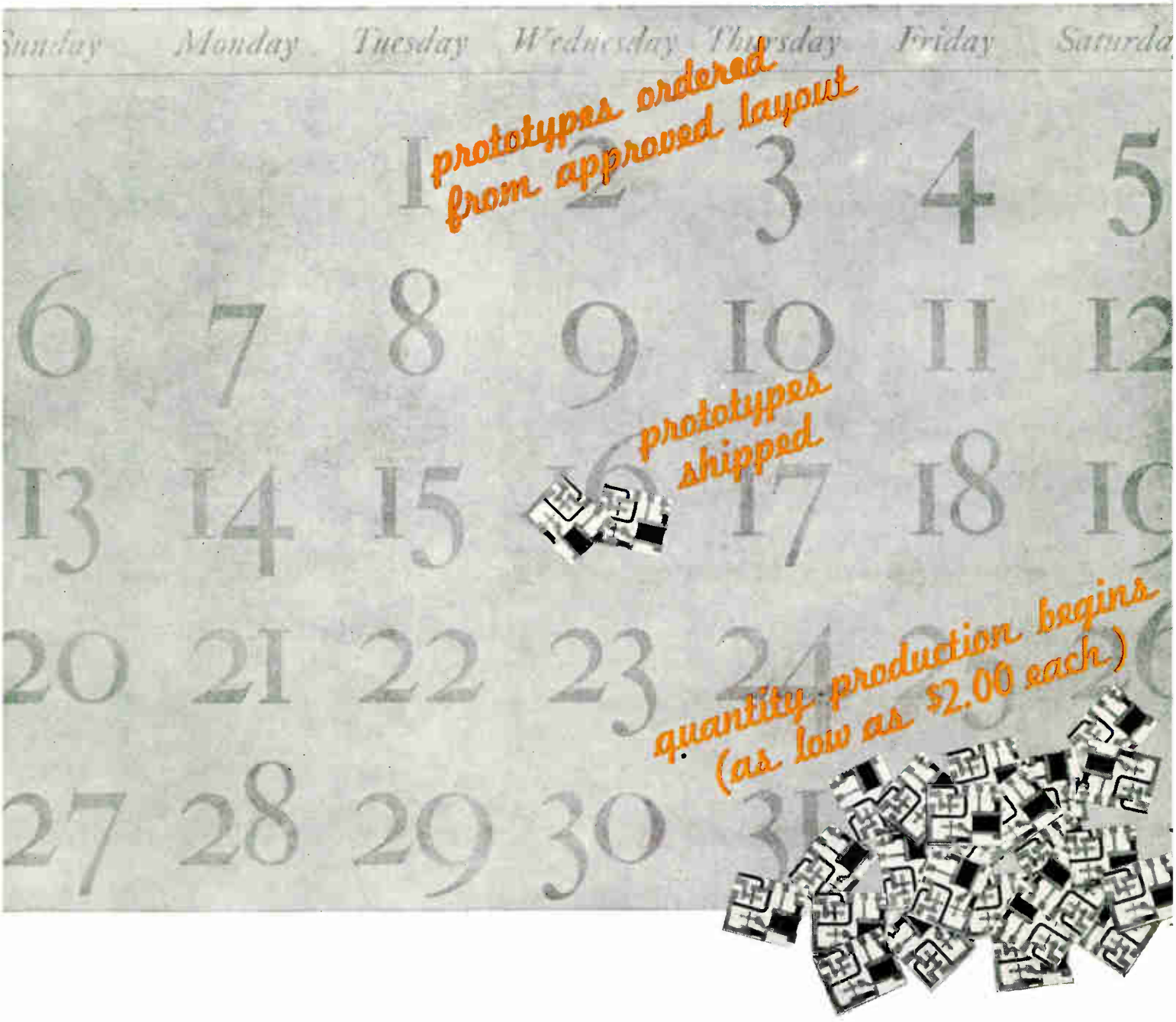
FAIRCHILD

DU MONT LABORATORIES
SCIENTIFIC INSTRUMENTS DEPT.

Circle 34 on Inquiry Card

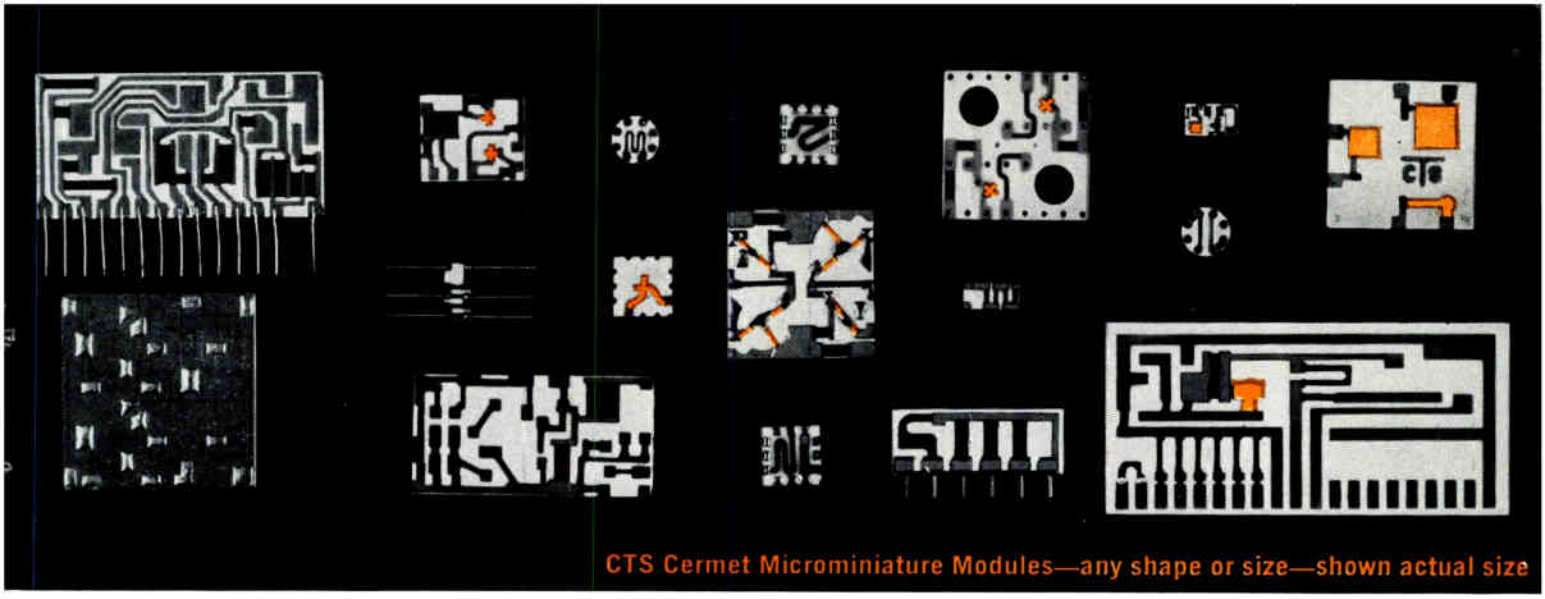
World Radio History

Now in large quantity production CTS Cermet Microminiature Modules



Circle 35 on Inquiry Card

World Radio History



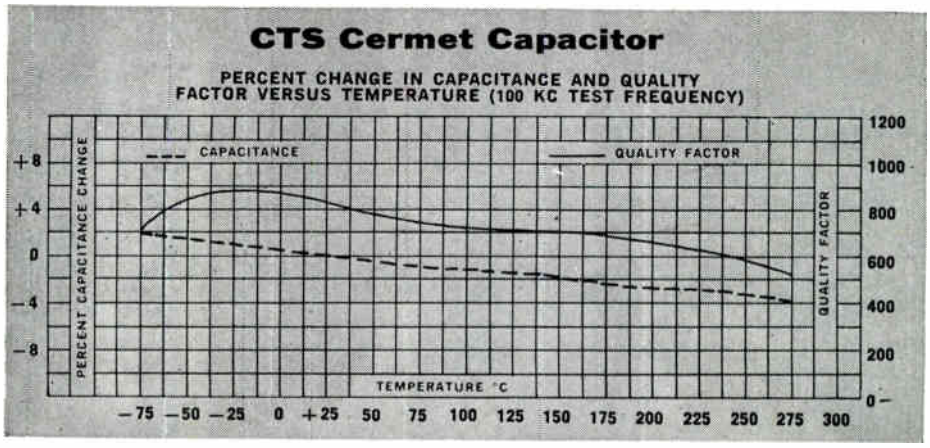
CTS Cermet Microminiature Modules—any shape or size—shown actual size

Born reliable at 650° C.

- **Unusually stable** and substantially unaffected by the most severe environmental extremes due to the virtually indestructible combination of a matrix of inorganic material and precious metal alloys after firing.
- **Built-in heat sink** because the alumina substrates have high thermal conduction.
- **Unaffected by solder.** Modules can be immersed in solder to tin selected conductive tabs or solder discrete components without effect on the cermet resistors and capacitors.
- **Elements can't separate from substrate** during varying environmental conditions. Cermet resistors and capacitors are thermally bonded.
- **Perfect termination** due to similarity of compositions. Pt-Au conductor composition diffuses with the cermet compositions and becomes part of the substrate after firing.
- **Migration dangers eliminated** because no silver is used.
- **No cermet resistance element failures** after 36,000,000 element hours of extended load life reliability tests. Only 0.172% average resistance change at full rated load.
- **Extremely tight quality control** in purchased materials inspection, in-process control of production procedures, step-by-step product inspection, and quality assurance program on completed product.
- **Fired at temperatures exceeding 650°C** so cermet resistors, capacitors and conductive circuit take excessive overloads without failure. Cermet resistors and capacitors operate continuously at 275°C; take short periods of 500°C.

How you can benefit from our design and development experience: We'll evaluate your circuit for incorporation into the new CTS cermet resistor-capacitor module microminiaturized packaging system. Interconnecting circuitry for maximum reliability will be "designed in." Our design engineering group will propose circuit layouts on one or both sides of alumina substrates including positioning of discrete active components using "fired-on" conductive circuits and "fired-on" cermet resistors and capacitors.

CTS Cermet Resistors meet MIL-R-10509



Request complete specifications and information.

Founded 1896

CTS® CTS CORPORATION
Elkhart, Indiana

Sales Offices and Representatives conveniently located throughout the world.

Principal Products
Variable Resistors
Selector Switches
Loudspeakers
Trimming Potentiometers
Microminiature Components
Electronic Circuit Packages

Subsidiaries
CTS of Asheville, Inc., Skyland, N. C.
CTS of Berne, Inc., Berne, Indiana
CTS of Paducah, Inc., Paducah, Kentucky
Chicago Telephone of California, Inc., South Pasadena, Calif.
CTS of Canada, Ltd., Streetsville, Ontario

Radio Museum

DESIGNING SOLID STATE SCANNING CIRCUITS

The recently announced solid state gate controlled switch holds some exciting promises for circuit designers. An immediate one is in a TV horizontal scan circuit. A complete description of the circuit design and its significant advantages are thoroughly explained.

By JOHN W. MOTTO, Jr.
Westinghouse Electric Corp.
Semiconductor Div.
Youngwood, Pa.

THE TURN-OFF REQUIREMENTS of a typical horizontal tv scan circuit are that 1500 va must be switched off in less than 1 μsec at the standard 15.75 KC horizontal scan repetition rate, f_s. The ability of a gate controlled switch (gcs) to do this job makes possible a horizontal scan output sufficient to drive a 19 in. 110° cathode-ray tube having an acceleration potential, V_{HV}, of 15 kv.

The circuit operation and performance of a gate controlled switch horizontal scan circuit is evaluated, the circuit generates 2500 va of horizontal scan power and 15 kv, V_{HV}, at 150 μa, I_{HV} for electron beam acceleration.

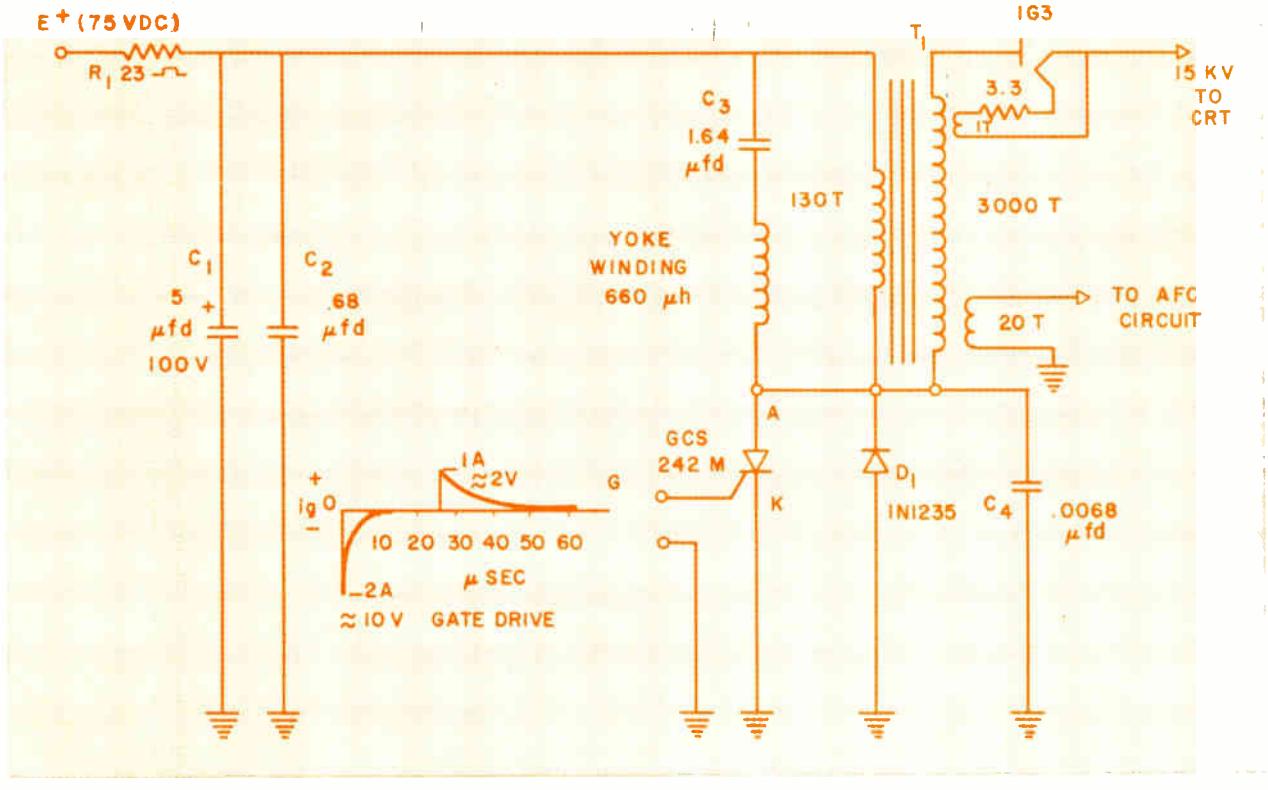
* * *

Circuit Operation

The basic gcs horizontal scan circuit is shown in Fig. 1. Dissipation in the gcs used in this circuit is only 7w. This power loss, in comparison to the typical 15 w. of heater power required for vacuum tubes employed in the same application, indicates the improvement in circuit efficiency.

The operation of this circuit is that of the conventional flyback scan circuit where the gcs replaces the horizontal output tube, and the semiconductor diode replaces the damper tube. When a positive gate pulse is applied to the gcs, it switches on and a step of voltage, E^+, is applied to the yoke winding. This results in a linear increase in current, i_Y, which is re-

Fig. 1: This horizontal TV scan circuit makes use of a recently developed gate controlled switch. Good efficiency is a feature of device.



World Radio History

quired for linear sweep of the electron beam across the CRT.

When the scan is completed at the right side of the picture, a negative gate pulse is applied to the gcs. The 3a. peak current is switched off, very rapidly, typically in 200 nsec; and the energy stored in the yoke inductance is transferred to C_4, charging C_4 to 500 v. in typically 2 μsec. This voltage is also impressed on the primary winding of T_1, a conventional flyback transformer. The high voltage induced in the secondary is rectified to provide 15 kv accelerating potential to the CRT.

The yoke inductance and C_4 will continue to oscillate for another half cycle, at which time the current in the yoke winding is about 2a., but opposite in direction to the current which was flowing when turn-off occurred. The yoke inductance will attempt to keep the current flowing in this direction, and can, as there is a low impedance path through the source and the damper diode, D_1.

This is the start of the horizontal scan, with the yoke current at some negative value decreasing linearly to zero. At zero current, in about the middle of the CRT screen, the gcs is turned on, and current increases linearly through the yoke winding in the positive direction. Note that the timing of the turn-on pulse is not critical and may be applied slightly before the gcs is ready to accept current. This variable conduction time will permit the gcs to make up losses in the circuit and will result in good high voltage regulation.

Resistor R_1 and capacitors C_1 and C_2 form a protection circuit for the power supply, E^+, the gcs, and the horizontal tv scanning circuit components, in the event of a gate drive failure. Normally, C_1 and C_2 charge very close to E^+ and act as the supply source for the circuit. However, if the gate drive circuitry fails right after a turn-on pulse is applied to the gcs, the current through the gcs would be limited only by the flyback transformer primary resistance which is very low. However, R_1 limits this current to 3a., and no damage will occur to the circuit components or power supply.

Placing R_1 in series with the supply voltage is possible because the current through R_1 is due only

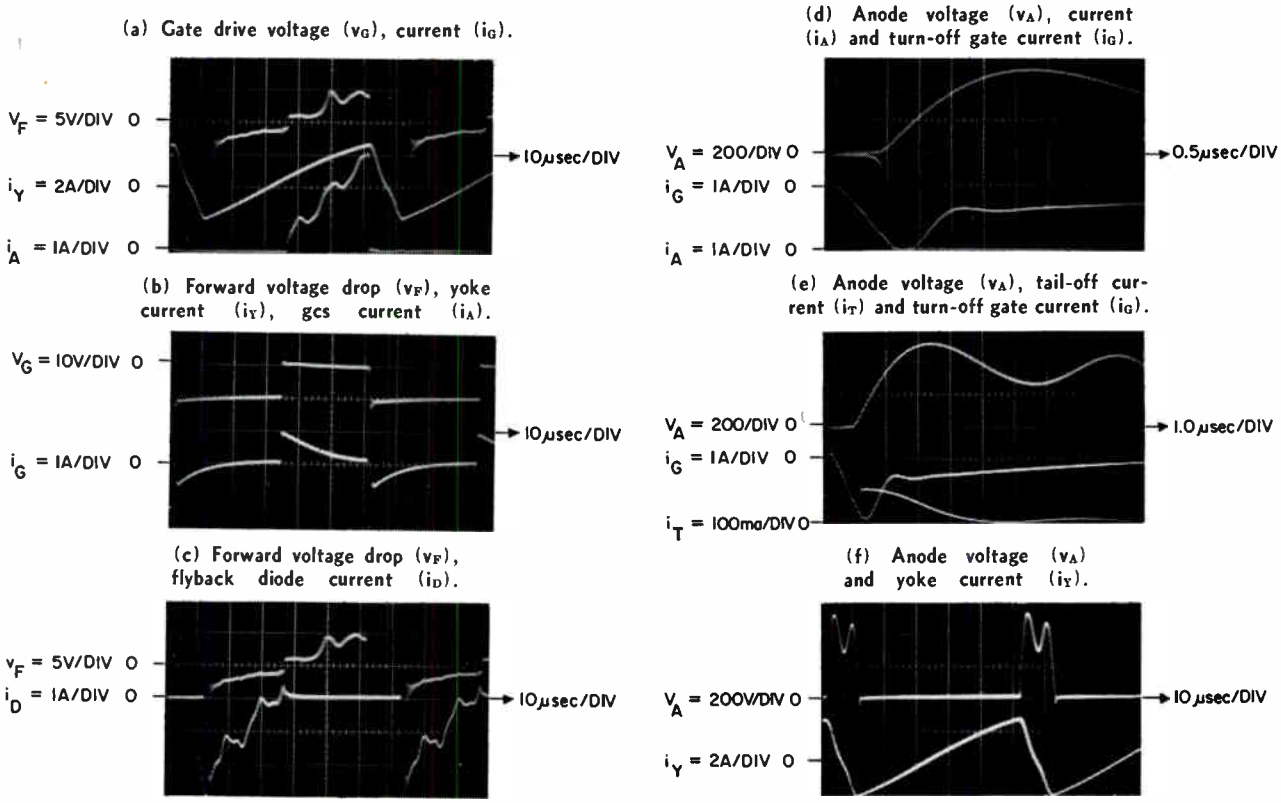
What Is A GCS?

The gate controlled switch (gcs)[1] is a three junction, three terminal solid state switching device. It is similar to the better-known silicon controlled rectifier. The gcs has the desirable characteristics of a silicon controlled rectifier: high blocking voltage, low forward voltage drop, surge current ability and pulse turn-on. In addition, the gcs has the ability to turn-off by applying a negative current pulse to the gate.

The gcs is capable of extremely high volt-ampere turn-off in very minute turn-off times. This turn-off ability is the primary requirement of a solid state switch employed in horizontal television scanning.

The combined features of pulse gate turn-on, pulse gate turn-off, and surge current ability are not found in any other solid state switch. Such features are distinct advantages in industrial control, auto ignition, high-frequency inverters, dc converters, voltage regulators and many other switching applications.

Fig. 2: Photographs show typical gate controlled switch horizontal TV scan waveforms.



World Radio History

to the losses in the circuit plus the high voltage power. The power input to this circuit is 30 w., of which about 4 w. are dissipated in R_1.

Capacitor C_3 does not alter the operation of the circuit but blocks any dc component in the yoke and compensates the linear yoke current to account for the curvature of the picture tube.

Note that the peak current of the gate pulses is nigh; but the gate voltage is low, and the pulse duration is only 5 μsec for turn-off and 15 μsec for turn-on. The average gate power is therefore quite low, approximately 2 w. for the waveform indicated.

Design Criteria

The peak flyback voltage and peak-to-peak yoke current product are basic measures of horizontal scan performance. For example, a 110°, 19 in. CRT with 15 kv is known to require a va product of about 2500.

The peak forward blocking voltage of 500 v. is practical for the gate controlled switch. The peak-to-peak yoke current would be 2500/500=5 a. As there will be losses in the circuit and in the generation of high voltage, the gcs must switch over half of this current, e.g., 3a.

Assuming the losses in the circuit are negligible, the yoke energy, $\frac{1}{2}LI^2$, will be transferred to the capacitor, $\frac{1}{2}CE^2$. Then, the peak flyback voltage will be:

$$v_{FB}(P) = i_A(P)\sqrt{\frac{L}{C}}, \qquad (1)$$

where $i_A(P)$ is the peak anode current through the gcs. The source voltage will be related to the yoke inductance thus:

$$e = L\frac{di}{dt}\ ;\ E^+ = L\frac{I_{PP}}{t_S}, \qquad (2)$$

where I_{pp} is the peak-to-peak current. As there is a specified retrace time interval, the yoke inductance and flyback capacitance are related as follows:

$$t_r = \pi\sqrt{LC},\ \text{where } t_r = \text{retrace time of the electron beam};\ C = \frac{t_r^2}{L\,\pi^2}\cdot \qquad (3)$$

Eqs. 1, 2 and 3 can now be combined to derive the fixed ratio of peak flyback voltage to source voltage.

$$\frac{v_{FB}(P)}{E^+} = \frac{i_A(P)\sqrt{\frac{L}{C}}}{L\ 2\ \frac{i_A(P)}{t_S}} = \frac{\pi\ t_S}{2\ t_r} = 8.4$$

Where t_S = period of horiz. scan freq.
The source voltage, E^+, is:

$$E^+ = \frac{v_{FB}(P)}{8.4} = 60\ \text{v.}$$

The yoke inductance, from Eq. 2, is

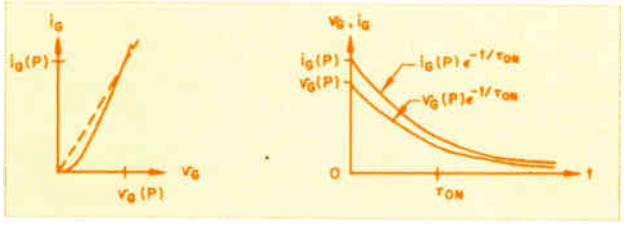
$$L = \frac{E^+\ t_S}{I_{PP}} = 640\ \mu h.$$

This is the approximate value of yoke inductance employed in the gcs scan circuit evaluated, and the measured voltages and currents are in satisfactory agreement.

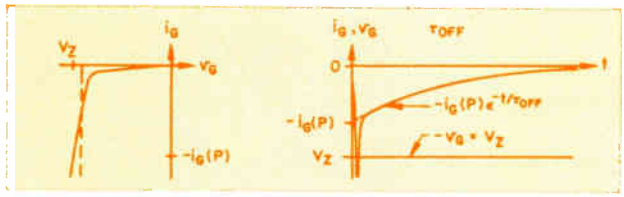
Waveforms

The waveforms of the gcs horizontal scan circuit are given in Fig. 2. The gate drive employed with a 1 a. turn-on peak current, and a 2 a. peak turn-off current, is shown at (a).

(a) Turn-on gate drive waveforms.



(b) Turn-off gate drive waveforms.



(c) Forward conduction waveforms.

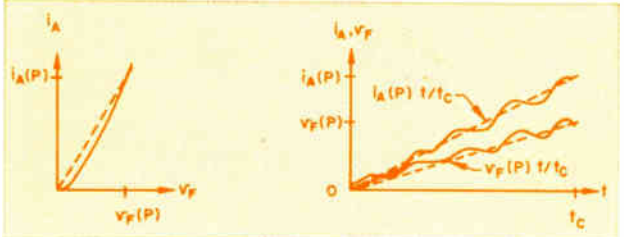
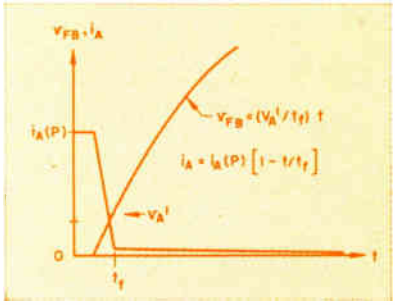
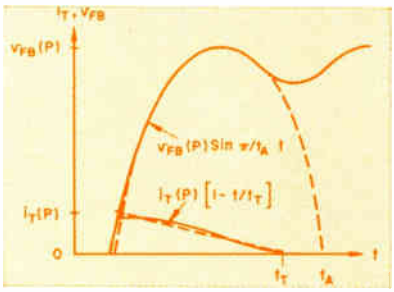


Fig. 3: Approximations of voltage and current waveforms for power loss calculations.

(d) Fall-time waveforms.



(e) Tail-off waveforms.



World Radio History

The peak power of the gate pulses is quite high, but the pulse time constants are only 13 μsec. The average power is therefore low, about 2 w for the gate drive employed.

The anode current through the gcs, building up linearly to 3 a, is shown in Fig. 2(b). The 2 a peak flyback current through the flyback diode is shown at (c). Shown at (d) is the 200 nsec current fall time of the gcs and the rise in anode voltage to 520 v in 2.0 μsec. The 2500 va generated scan power is shown at (f).

The measured values for two gate controlled switches are given in Table 1. The units were selected to represent a typical device, Unit No. 1, and a marginal device for this scan power, Unit No. 2. These data will be employed in calculating the power dissipated in the gcs.

Power Losses

Several factors that determine the total power dissipation in the gate controlled switch will be examined individually to learn the relative contribution of each.

Gate Drive. The gate drive suggested for the gcs is shown in Fig. 1. The turn-on pulse has a peak magnitude of 1 a. and a 10 μsec time constant. The turn-off pulse has a peak amplitude of 2 a. with a time constant of 5 μsec.

Turn-On Gate Drive. The application of positive voltage on the gate of the gcs with respect to cathode results in a positive gate current which switches the gcs into the conduction state. The relationship of positive gate voltage and current is that of a forward biased p-n junction with a small resistance component. This is shown in Fig. 3 (a).

Assuming the 0.5 threshold voltage can be approximated as zero, the gate voltage-current relationship is linear as given by the dotted line in Fig. 3 (a). The turn-on gate drive employed was the charging current of a differentiating capacitor. The current is therefore exponential decreasing and, due to the linear relationship between the current and voltage, the voltage is also decreasing exponentially, as shown. The power dissipated due to the turn-on pulse would be:

$$P_{ON} = v_G(P)\, i_G(P)\, f \int_0^{t_C} \epsilon^{-2t/\tau_{ON}}\, dt,$$

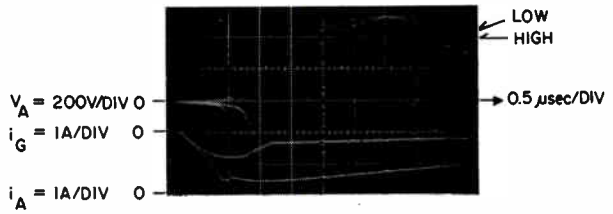
where V_G and i_G are the gate to cathode turn-on voltage and current, respectively.

$$P_{ON} = \frac{v_G(P)\, i_G(P)\, f\, \tau_{ON}}{2}\left[1 - \epsilon^{-2t_C/\tau_{ON}}\right]. \qquad (4)$$

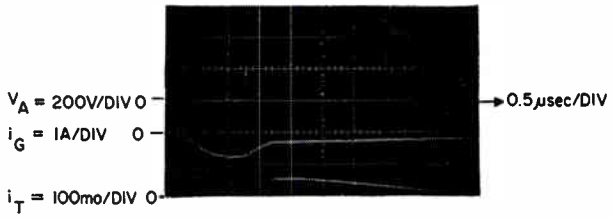
The turn-on gate drive power for Unit No. 1 calculated by this equation, is 0.2 w.

Turn-Off Gate Drive. The application of a negative voltage on the gate of the gcs results in a negative gate current which switches the gcs into the blocking state. The relationship of negative gate voltage and gate current is a low voltage Zener diode

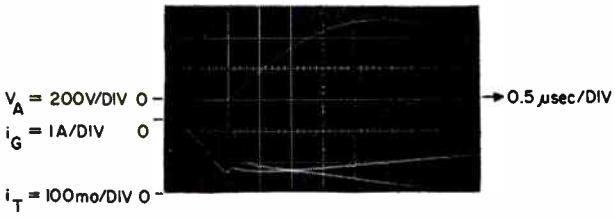
Fig. 4: Variations in TV scan waveforms due to gate drive.



(a) Anode voltage (v_A), current (i_A), high and low gate drive.



(b) Tail-off current (i_T), low gate drive.



(c) Tail-off current (i_T), high gate drive.

as illustrated in Fig. 3(b). The negative gate voltage can, therefore, be approximated as independent of negative gate current. The gate waveform applied is the discharge of the differentiating capacitor and is also of exponential order as shown. The actual turn-off pulse, as seen in Fig. 2(a), employed a speed-up capacitor which produced an initial 2 a. peak to aid in the fall time of the gcs. This turn-off gate drive wave shaping is important, as the turn-off pulse is a significant part of the total device power dissipation as will be shown later. Approximating the power due to the speed-up capacitor as negligible, the voltage and current equations will be:

$$i = -\, i_G(P)\, \epsilon^{-t/\tau_{OFF}};\ v = -\, V_Z,$$

Where V_Z is the gate-to-cathode zener breakdown voltage. The power dissipated, due to the turn-off pulse, is:

$$P_{OFF} = V_Z\, i_A(P)\, f \int_0^{t_{XC}} \epsilon^{-t/\tau_{OFF}}\, dt;$$

Where t_{XC} is the flyback time + diode conduction time.

$$P_{OFF} = V_Z\, i_A(P)\, f\, \tau_{OFF}\left[1 - \epsilon^{-t_{XC}/\tau_{OFF}}\right]. \qquad (5)$$

The turn-off gate drive power for Unit No. 1, calculated by this equation, is 1.77 w.

Forward Conduction Losses. The forward voltage drop of the gcs results in device power dissipation as the yoke current increased to the peak value. The relationship between the forward voltage drop and the forward conduction current through the gcs is that of the forward biased p-n junction with a minute resistive component and can be approximated as a

World Radio History

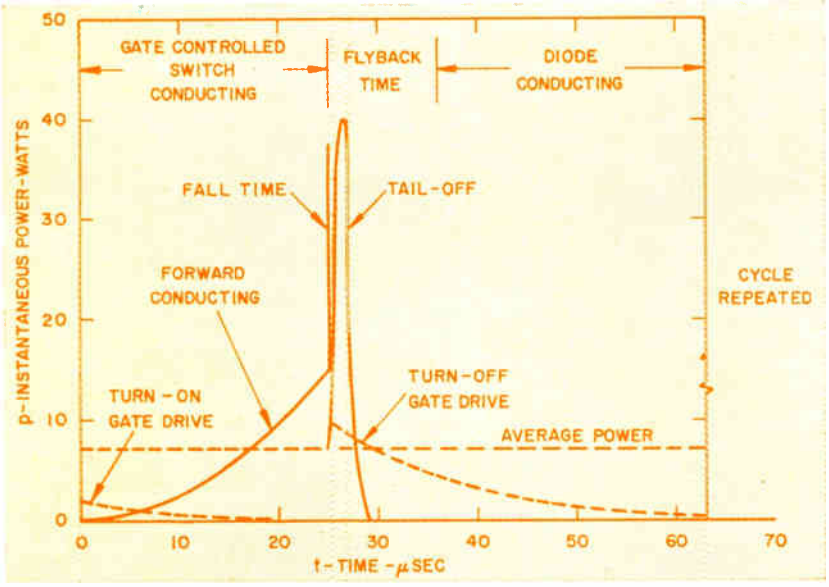


Fig. 5: Curve shows instantaneous power dissipated (p) in gcs.

Table 1.
EMPIRICAL DATA ON GCS TV SCAN CIRCUIT

Parameter	Unit	
	No. 1	No. 2
$i_A(P)$	3.0 a	3.0 a
$v_A(P)$	520 v	500 v
$i_Y(P\text{-}P)$	4.7 a	4.5 a
V_{HV}	15 kv	14 kv
I_{HV}	150 μa	140 μa
E^+	73 v	70 v
I_**	310 ma	360 ma
P_{IN}**	22.6 w	25.2 w
$+i_G(P)$	1.0 a	1.0 a
$+v_G(P)$	2.0 v	2.0 v
$-i_G(P)$	2.0 a	2.0 a
$v_F(i_F=3\text{ a})$	5 v	1.5 v
V_A'	50 v	100 v
i_T	150 ma	400 ma
t_T	4 μsec	5 μsec
t_f	0.2 μsec	0.45 μsec
$-v_G(P)$	10 v	12 v

*Source current; **Source power. (P) = peak; (P-P) = peak to peak.

linear relationship by disregarding the threshold voltage as shown in Fig. 3 (c). The linear increase in anode current will therefore result in a linear increase in forward voltage drop, i.e.:

$$i = \frac{i_A(P)}{t_C}\,t;\; v_F = \frac{v_F(P)}{t_C}\,t,$$

Where t_C = conduction time of the gcs. The power dissipated will therefore be:

$$P = \frac{i_A(P)\,v_F(P)\,f}{t_C^2}\int_0^{t_C} t^2dt;$$

$$P = \frac{i_A(P)\,v_F(P)\,f\,t_C}{3} = (.132)\,i_A(P)\,V_A(P). \qquad (6)$$

The forward conduction losses for Unit No. 1, employing this equation, is 1.98 w.

Fall Time Losses. There is a finite time necessary for the anode current through the gcs to fall to about zero. Fortunately, the voltage across the gcs is dictated by the resonant circuit of the yoke inductance and flyback capacitance and remains low during this time. The fall in anode current can be approximated as a decreasing ramp, shown in Fig. 2 (d). The voltage, which is a sine wave with a large third harmonic component, can be readily approximated as an increasing ramp function for the initial rise to the peak value of the voltage. Unfortunately, this peak voltage must be a measured value.

The second harmonic component of flyback voltage result is an extremely complex circuit equation to evaluate the peak anode voltage, V_A', at the end of the current fall time. This peak voltage will increase with increasing fall times, but not at the rate which might be expected. This is shown in Fig. 4(a) where the fall time has been increased appreciably by reducing the turn-off gate drive. Note that the anode voltage shifts in phase, and the V_A' increased only slightly due to the increase in fall time.

The gcs current and voltage can be described during the fall times by:

$$i = \frac{-\,i_A(P)}{t_f}\,t + i_A(P);\; v = \frac{V_A'}{t_f}\,t,$$

Where t_f = fall time of anode current on turn-off. The power dissipated will be:

$$P = \frac{i_A(P)\,V_A'\,f}{t_f}\left[\int_0^{t_f} t\,dt - \frac{1}{t_f}\int_0^{t_f} t^2dt\right];$$

$$P = \frac{i_A(P)\,V_A'\,f\,t_f}{6}. \qquad (7)$$

The fall time loss for Unit No. 1, employing this equation, is 0.08 w.

Tail-off Losses. The fall-time of anode current for the gcs is not from 100 to 0%. The anode current drops to a low value, typically 5%, for the circuit being described and then "tails-off" to zero in typically 5 μsec. This current, termed the fail-off current, while small, results in significant power dissipation in the gcs. The tail-off current and voltage waveforms are shown in Figs. 2 (e) and 3 (e). The tail-off current has been approximated as a decreasing ramp, and the voltage as a sine wave of the fourth harmonic of the fundamental flyback frequency. This is seen in Fig. 3(e). The voltage and current equations are, therefore:

$$v = v_{FB}\,\mathrm{Sin}\,\frac{\pi}{t_A}\,t;\; i = \frac{-\,i_T(P)}{t_T}\,t + i_T(P),$$

Where t_A = the alternation time of fourth harmonic during flyback; i_T = anode tail-off current on turn-off; t_T = time to reduce tail-off current to zero. The

World Radio History

power dissipated during the tail-off interval will be:

$$P = v_{FB}(P)\, f\, i_T(P) \left[\int_0^{t_T} \text{Sin} \frac{\pi}{t_A} t\, dt - \frac{1}{t_T} \int_0^{t_T} t \text{ Sin} \frac{\pi}{t_A} t\, dt \right];$$

$$P = \frac{V_{FB}(P)\, i_T(P)\, i_T(P)\, f\, t_A}{\pi} \left[1 - \frac{t_A}{t_T \pi} \text{Sin} \frac{\pi}{t_A} t_T \right] \cdot \quad (8)$$

The tail-off power for Unit No. 1, employing this formula, was 1.53 w.

Forward Blocking Losses. The forward blocking leakage current through the gcs during the flyback interval results also in a possible power loss. This current, however, is rarely greater than 5 ma. at the maximum junction temperature; and the resulting power would not be greater than 100 mw.

Instantaneous Power Dissipation

The analytical expressions established for the voltage and current waveforms of the gcs in the horizontal scan circuit permit the calculation of instantaneous power dissipated as a function of time. This power, as shown in Fig. 5, is required to determine peak juncture temperature.

The thermal time constant of semiconductors, such as the gcs, is low; and the junction temperature will reach a peak value higher than the average power and steady state thermal impedance indicates.

The instantaneous power plot has been approximated as an average value based on the average power previously calculated plus a rectangle with a height equal to the peak of the tail-off power and the width equal to the tail-off power pulse width.

The thermal time constant or transient thermal impedance for pulse width this short of duration can only be approximated and extrapolated from transient thermal impedance measurements at longer pulse widths. The transient thermal impedance junction to case in °C/watt is given by [2]:

$$\theta_{(t)} = \theta_{(t)}\ (100\ \mu\text{sec}) \left[1 - \epsilon^{-t/25\ \mu\text{sec}} \right] \quad (9)$$

The transient thermal impedance at 100 μsec of the gate controlled switch employed is 0.24°C/w. The extrapolated transient thermal impedance for 5 μsec, the length of the tail-off power, would be 0.043°C/w.

The steady state thermal impedance of the gate controlled switch employed is 2.0°C/w. The temperature rise due to average power would be 11.12°C for Unit No. 1 and 15.2°C for Unit No. 2.

The transient temperature rise would be 1.7°C for Unit No. 1, and 5.0°C for Unit No. 2. This however, is a conservative approximation, as the area in conduction at turn-off is not the total junction area, and the capacitance of the device to absorb heat is greatly diminished. The complexity of the problem has led to an area factor approximation of 10.0 to be introduced into the transient thermal impedance. The transient temperature rise will then be 17°C and 50°C for Units No. 1 and No. 2, respectively.

The total junction temperature rise is assumed to be the steady state plus the transient temperature rise. The maximum junction temperature of the devices employed is 125°C; the permissible case temperatures for Unit No. 2, the marginal device, would be 60°C.

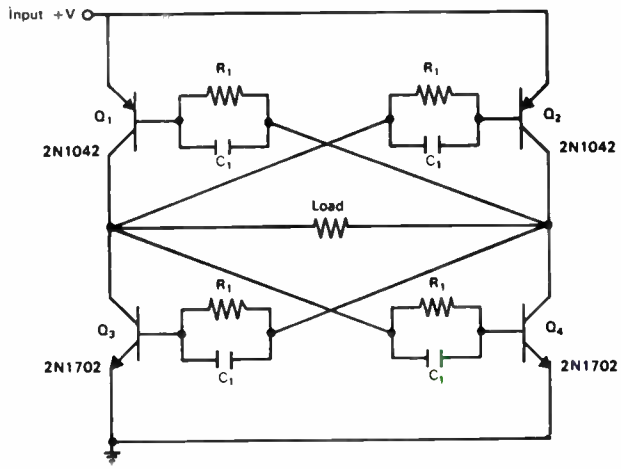
Acknowledgements

Acknowledgement is due several people at Westinghouse whose work has brought the gcs tv scan circuit to present state of development. Mr. Alec Walker was primarily responsible for the initial application of the gcs to horizontal television scanning. Messrs. Charles Heffron, and Robert Murray, were extremely helpful, as well.

References

1. *Characteristics of the Gate Controlled Turn-Off TRINISTOR Controlled Rectifier*, J. W. Motto, Jr., IEEE Conference Paper. CP 63-510, Jan., 1963.
2. Westinghouse *Silicon Controlled Rectifier Handbook*, Robert Murray, Jr., Editor, August 1963.

SQUARE-WAVE OSCILLATOR



A COMPACT SQUARE-WAVE OSCILLATOR has been developed that will operate with high efficiency at relatively high power levels. The circuit contains only simple resistor-capacitor combinations and solid-state devices.

The circuit is a symmetrical bridge with a transistor in each arm. The base of each transistor is connected to a parallel resistor-capacitor combination as shown in drawing. Each combination is connected to the collector of the diagonally opposite transistor. The selection of transistors is the most important design consideration. A smooth, balanced operation is provided by using a matched pair of pnp transistors, Q_1 and Q_2, and a matched pair of npn transistors, Q_3 and Q_4. In addition, these pairs should be complementary.

NASA Tech Brief 63-10554. Contact Technology Utilization Officer, Goddard Space Flight Center, Green Belt, Md. 20771 for further information.

World Radio History

ELECTRONIC INDUSTRIES

STATE-OF-THE-ART FEATURE

WHERE THIN FILMS ARE TODAY

Over a period of about ten years millions of dollars have been spent developing thin films. Some of the latest equipment is now using thin film circuits. This article is a frank technical discussion of where thin films stand today and what the possible future will be.

By ARTHUR MEEHAN
Light Military Electronics Div.
General Electric Co.
Utica, N. Y.

THE RECENT TECHNICAL EXPLOSION IN MICROELECTRONICS has fostered a variety of techniques to achieve the desired objectives. Simultaneously, a confusing array of terms has evolved to describe these techniques. To reduce some of this confusion, let me stipulate the following definition: A thin film circuit is one in which the majority of passive elements are formed in thin layers on a non-conductive substrate.

This definition infers that all active components and, in certain cases, some passive elements are added to the circuit as discrete parts. Reference will be made later to the "pure" thin film circuit in which all elements are formed in thin layers.

There are at least three dozen companies producing thin film circuits either for sale to the open market or for in-house use. Millions of dollars in equipment and man hours have been expended in this area over the past ten years.

* * *

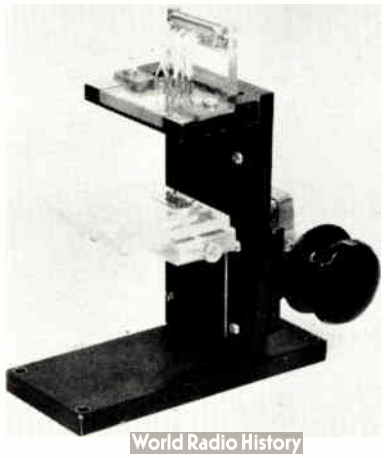
Several times during this period it seemed that the application potential of thin film circuits would be susperseded by other methods. Yet despite the rapid advances in integrated circuit technology and miniaturizing discrete components, the thin film approach today affords even greater opportunities to produce more reliable, low cost equipment. By using these other advances along with improvements in thin film techniques, companies can provide more versatility with thin films. This is not to say that thin films are superior to other approaches since each has its own advantages and limitations. Ultimately each equipment application dictates the optimum method of solving the problem.

Two recent applications, one military and the other commercial, provided renewed interest in thin films. The improved Minuteman guidance computer, though largely designed with integrated circuits, contains a significant number of thin film circuits.[1] The recent announcement by IBM that the new 360 series of commercial computers would make wide use of thin film circuits indicates that they can be competitive if they are used wisely.

Thin film technology, keeping our previous definition in mind, can be divided into two categories and three basic processes. The two categories are "thick" and thin films. Thin films produced by the vapor deposition process are usually limited to a thickness of 15,000 A (1 angstrom = 10^{-8} cm). The material to be deposited is heated in a vacuum of about 10^{-6} torr and deposited through a mask to the desired geometry on an inert substrate. Film thickness can be as low as 150 Å. Films produced by cathodic sputtering are classified in the same category as films produced by vapor deposition in this discussion.

The second category is "thick" films. The most popular technique here is silk screening a glass frit material on a ceramic substrate and then firing the substrate at a temperature between 600° and 800° C. Other methods of producing "thick" films are spraying and chemical deposition. Thick films usually have a thickness of 0.5 to 1.0 mils. It is not our intent to discuss the relative merits of these two techniques, but rather to highlight some of the recent advances.

Fig. 1: Fixture is used to make a functional check of the substrate without actually attaching the active components.



Circuit Design

The average circuit designer is more apt to undertake a thin

World Radio History

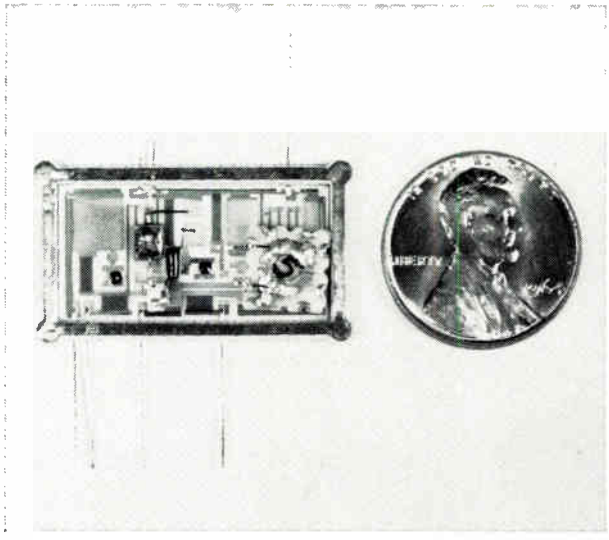


Fig. 2: A 120 mc oscillator mixer uses a micro inductor and a micro crystal with thin film circuit.

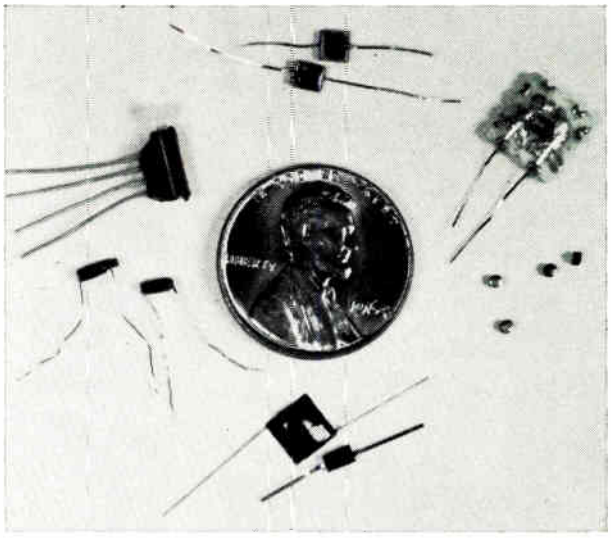


Fig. 3: Various thin film components, in pico form, are shown prior to attachment to a substrate.

film design than to use integrated circuits. Probably this is so because he has not yet learned to think of components in terms of functions. He would rather cling to the old ways of measuring each and every component in his circuit. With the thin film technique, access to every part is possible. However, it is better to treat the thin film circuit as a function than to be concerned with each component.

Fig. 1 shows an inexpensive fixture which permits a functional test of the basic substrate without physically attaching the active components. Worst-case transistors and diodes are attached to pressure pins at the top of the fixture. Other pressure pins pick up specific points on the substrate so that a variety of conditions can be applied to the circuit. Only units passing this worst case functional test are sent to assembly.

The circuit designer is also more relaxed with a thin film design because of the usual one-to-one transformation from conventional design to a thin film micro design. Fig. 2 is a 120 MC oscillator mixer which shows the application of thin film components in this one-to-one relationship. Components which cannot be thin-filmed are available in pico form for attachment to substrate. This group includes crystals, inductors, transformers, large valued capacitors, and resistors. (See Fig. 3.)

What are the best applications for thin films? At times the decision will be obvious; high frequency (20 MC) and high power (200 to 600 mw) would rule out silicon integrated circuits, for example, but these are relatively simple in thin films. Other considerations would depend on the total amount of resistance and capacitance in the circuit. For example, if the circuit contained more than 50,000 ohms or if the resistance tolerance was critical, thin films would be in order. It also does not pay, as a rule, to consider integrated circuits unless the quantities of circuits involved are in excess of 2000, or unless an off-the-shelf circuit is available. This is so because of the initial costs of several thousand dollars for a custom design integrated circuit.

Thin Film Masks

Significant advances in the drafting, photo, and metallic mask areas have been made in the past year. If masks are to be used, as in the case of vapor deposited films, a separate pattern for each material layer must be made. This usually starts out with a ten times enlargement scribed on a stable material. To increase deposition yield, and therefore reduce overall costs, extensive use is made of a coordinatorgraph to trace the pattern. This machine is accurate to 0.0002 inch across a 48-inch span. Special cutters have been designed to insure line width.

In many cases the designer wants to deposit several of the same circuits on a substrate. Rather than draw the circuit pattern for each circuit repetition, he can use a step and repeat camera, which allows one pattern to be drawn and reproduced on a photo plate making use of only one camera setup.

In the area of masks for thin film work, metal is by far the most widely used. A typical mask is about 3 mils thick. This is ideal for achieving an exact deposition pattern but presents a handling and fixturing problem which may be overcome by two methods. A thick, 10-12 mil, backup mask may be used. This is overetched so as not to interefere with the deposition pattern, but it does give adequate support to the flimsy pattern mask. Usually a copper alloy is used for the mask material. Since the chemical etch of the mask is not easily controlled to tight dimension, an etch-resistant material, e.g. nickel, is plated over the copper. The areas to be etched are protected with a photo resist during nickel plating. Since plating can be done much more precisely than etching, the area to be etched can be precisely defined in this fashion.

World Radio History

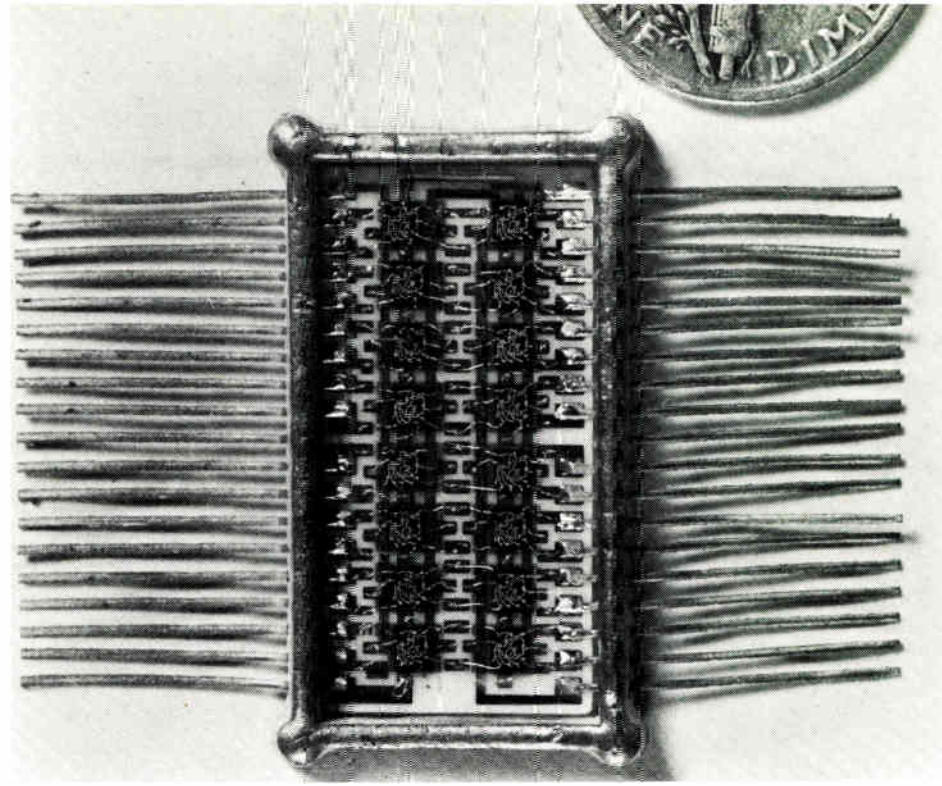


Fig. 4: Hermetic case shown here seals 16 single-crystal circuits mounted on a thin film substrate to form a package.

A second mask approach is to use a thick material and rough machine the slot areas until the material is only a few mils thick in the desired locations. A final etch then completes the mask.

The Naval Avionics Facility, Indianapolis, uses graphite masks. A numerically controlled milling machine is used to machine the entire mask. NAFI expects a saving of over $500,000 this year using this method.

Most companies in the field hold developments in the drafting, photography and mask-making area to be highly proprietary. Therefore many specific details are not available for publication.

Masking techniques for thick film assemblies are usually cheaper than those used in vapor deposition. The two reasons for this are that the masks are not flimsy and usually are not held to tight tolerances. Most thick film processors trim individual resistors by removal of excess material, and so the initial screening can be much less precise.

Although many materials are available for vapor deposition, the most commonly used are nichrome, aluminum and silicon monoxide. Other systems make use of sputtered tantalum, or tin oxide sprayed on the substrate. With both of these methods it is usual to cover the entire substrate and remove material to obtain a pattern.

Resistors

Even with precise masks and evaporator fixturing, it has been difficult to obtain close-tolerance deposited components. This deficiency was especially true when resistor values on a substrate would range from 100 to 50,000 ohms.

Tolerances of less than 10% were usually obtained by placing shorting bars on resistor elements and opening the bars to obtain incremental increases in resistance. At LMED a detailed investigation was made to learn why resistors of various values were not falling into the same tolerance ranges.

Critical items were found to be source design, fixturing, cleaning procedures, masks and circuit topology. The last item became most significant. A series of compensation factors was developed and applied to each circuit layout. Compensation, by either lengthening or shortening resistor lengths, is made depending on the width of the resistor, placement on the substrate, and the number of segments to the resistor. When these factors are put into the substrate design it is possible to deposit circuits with a yield of 90% at these tolerances:

resistors ±3% maximum ratio and ±5% absolute
capacitors ±10% absolute

Since deposited nichrome resistors are stable, (drift of 0.05% per 2000 hours at 100°C), these conditions will satisfy most designs. If absolutely necessary, resistors can be trimmed to less than 0.5%.

Capacitors

Silicon monoxide capacitors in the past have been plagued with pin holes causing shorts or low voltage breakdown. Much work has been done in source design, mask techniques, substrate cleaning and sputtering. Today silicon monoxide capacitors are regularly made with breakdown voltages in excess of 100 v.

For most digital applications, capacitors present no problem, but in linear circuits where much higher capacitance is used, silicon monoxide is limited. While it is possible to fabricate SiO capacitors up to 10,000 picofarads, it is uneconomical to exceed about 1000 pf. Not only does the yield suffer, but the amount of substrate area needed for a large capacitor is excessive. Stacking of layers is possible, but at lower yields. For high values, discrete capacitors are normally used.

Although most suppliers of thick film circuits use discrete capacitors for all values, the *IBM Journal of Research and Development* for April, 1964 (Davis, et al) has reported on screened frit capacitors.[2] These units use special glass-base materials alternately screened to form plates and dielectric layers. Capacitances of 75,000 pf/in.^{2} with breakdown voltages in excess of 200 v. are reported.

The most common substrate materials are glass, ceramics, and glazed ceramics. The thick film tech-

World Radio History

nique uses ceramics exclusively because of the high-firing temperatures required by the screened components.

Vapor deposition users have long been dissatisfied with glass for several reasons. It is fragile, a poor thermal conductor, and comparatively expensive. Recently, several vendors have developed glazed ceramics for the thin film industry. Not only is the glazed ceramic cheaper than glass, but the reject rate is much lower.

Were it not for the advancements made by the component vendors in reducing the size of discrete parts, the future of thin films would indeed be dim. Spurred in part by the Signal Corps micro-module program and the dot component approach to packaging, the component suppliers have been able to produce most components in sizes compatible with thin film assemblies. For example, it is impractical to produce thin film inductors; yet the types of circuits which require inductors are those which make thin films the choice over integrated circuits. Micro inductors are now readily available up to 7000 μh in a size 0.075 x 0.155 in. (See Fig. 3.)

Greatest Advancement

Perhaps the greatest advancement in thin film techniques to reduce basic costs is the use of transistor and diode chips in place of the pico devices. Until recently it has been the practice to purchase these active devices as tiny tabs upon which the transistor has been mounted, fine leads attached and covered with a suitable epoxy for mechanical and environmental protection. Because these devices are not produced by the millions, each order means that the semiconductor supplier must set up a special line, making the device a fairly expensive item. For example, one type of pico transistor, in large quantities, can be purchased for $8.50 each. The same device has been obtained in chip form without leads for $1.30 in small quantities. In quantities of 10,000, the cost would drop to about 30 cents.

Additional savings can be obtained by purchasing entire wafers of devices. The semiconductor supplier checks the devices and marks the defective unit. An example of typical savings is to compare a device costing $6.95 in thousand-lot quantities with an entire wafer. The wafer can be purchased, in these smaller lots, so that the individual transistor cost is about 30¢ for each good device.

After this wafer is scribed, the defective units are discarded, and the good units are then die attached to the thin film substrate. Two leads are attached to the device while the collector is directly fastened to the substrate in the die attach operation. In the case of a diode, only one lead need be attached because the anode becomes mechanically and electrically attached to the substrate. Diodes bought in wafer form result in devices that cost 6¢ for each good device.

Another method of using transistor chips is described by Davis, et al.[2] In this technique, thin glass coating is applied over the device. Holes are etched in the glass to expose the emitter, base, and collector contacts. Tiny metal balls are attached to these areas by soldering. The transistor chip with the metal balls in place is then inverted and soldered to the substrate.

In either of these approaches the transistor's overall cost, including any testing, additional assembly, or loss is much less than those of discrete pico parts. One present drawback to these techniques is the unwillingness of some semiconductor producers to market either chips or wafers, and, therefore, not all types are available. Integrated circuits can likewise be die attached to thin film substrates. This combination allows the designer to take advantage of the best features of each technique.

Much difficulty has been encountered in the industry in the use of plastic encapsulations with thin films. Under conditions of high temperature and humidity many films are chemically attacked. To avoid this condition more and more use is being made of hermetic enclosures for the thin film circuit.[3] In the use of die-attached, uncased transistors, diodes and integrated circuits this is mandatory. Fig. 4 shows such a case with 16 single crystal circuits mounted on a thin film substrate.

Just prior to final seal the circuit, with all components in place, is baked in vacuum at an elevated temperature. After bakeout the circuit is transferred directly to a dry box containing dry nitrogen where the top cover is applied. With such a process a more reliable unit is assured.

Is there a future for thin films? It is the writer's opinion that thin film circuitry in one form or another will be with us for many years to come. For the next year or two the types of fabrication detailed above will comprise most of the thin film work. Some use will be made of thin films deposited over integrated circuits. But, this technique is not yet far enough removed from the laboratory and may not see extensive use.

As has been true for several years, the development of thin film active devices holds great promise. Considerable laboratory work is being done in the area of field-effect and tunneling devices. However, since they are still in the lab they are not included in this discussion. It is doubtful that these devices will be incorporated into production processes much before the end of 1966. Their development, however, would enhance the position of thin films, making the assemblies more resistant to shock, vibration and nuclear radiation. In addition, their use would further decrease costs.

References

1. "Microelectronics and Minuteman," R. C. Platzek, *1963 WESCON Convention Record.*
2. "Solid Logic Technology: Versatile High Performance Microelectronics" Davis, E. M., Harding, W. A., Schwartz, R. S., Corning. J. J. *IBM Journal of Research and Development,* Vol 8, No. 2, April 1964.
3. "Hermetic Packages for Microsystems Electronics," Telfer, T., *Seventh National Convention on Military Electronics 1963 Convention Record.*

World Radio History

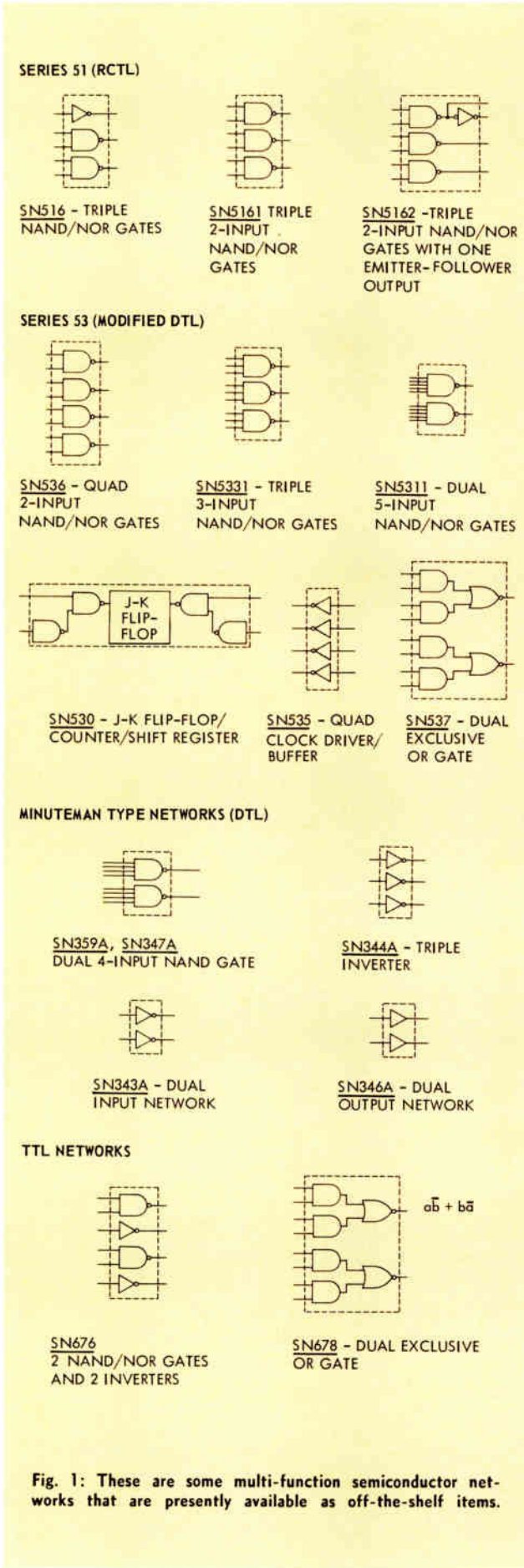


Fig. 1: These are some multi-function semiconductor networks that are presently available as off-the-shelf items.

ELECTRONIC INDUSTRIES
STATE-OF-THE-ART FEATURE

CUTTING SYSTEM COSTS WITH INTEGRATED CIRCUITS

Advancement in the state-of-the-art in semiconductor integrated circuits has been rapid. Reduced production costs and more circuits per package have led to lower prices per function. This coupled with reduced assembly costs and hardware, and increased reliability make them hard to overlook.

By WALT WEYLER
Integrated Circuits Product Eng.
Texas Instruments Incorporated
13500 No. Central Expressway
Dallas, Texas

THE PAST TWO YEARS have seen profound developments in the state-of-the-art of semiconductor integrated circuits*. These developments have culminated in the announcement of general availability of "multi-function" semiconductor networks with two, three, four or more complete circuits diffused into a single bar and contained in a single package.

A step-function decrease in the effective cost of integrated circuits, making them competitive with discrete components for most applications has resulted. Bonus benefits include fewer packages to handle, fewer connections, fewer circuit boards and less back-panel wiring—plus significantly improved reliability.

* * *

The multi-function semiconductor networks discussed here contain all the elements to perform several circuit functions within a single monolithic substrate. These elements are interconnected with deposited metallic lead patterns to achieve the desired circuit functions.

To fully describe the advantages of multi-function

* Patented by Texas Instruments Incorporated.

World Radio History

networks, it is necessary to examine them from several viewpoints. First, the presently available multi-function networks are described. Next, the integrated circuit manufacturing cost structure is described to verify the inherent economies of multi-function networks. Finally, two actual systems are analyzed to show the impact upon cost and reliability.

Available Multi-Function Networks

As early as October 1961, the first two multi-function networks were announced—the SN514 (Dual 3-input NOR/NAND gates) and the SN515 (three 2-input gates interconnected in the EXCLUSIVE OR configuration). These units are included in the Series 51 family of low-power digital circuits. Similar networks were also included in the higher-speed digital Series 53 line in the form of single networks containing two NAND gates, two AND gates, or four buffers.

The number of catalog multi-function networks available from Texas Instruments now totals more than 20. Fig. 1 shows the new units, along with a few of the earlier circuits.

Advances in Technology

Since 1960, the economies of manufacturing complex networks have changed dramatically, due to important advances in process technology. Fig. 2 plots the changing cost vs complexity curve for semiconductor networks for the past few years. In 1960, only very simple networks (10 to 15 components per bar) could be economically produced. Yields of more complex networks were so low and costs so high as to render them uneconomical to produce. Gradually, as process experience was accumulated, smaller element geometries and improved process controls were developed. Complex networks could be made with steadily increasing yields and at decreasing costs.

As an example of this progress, consider the two network bar shown in Fig. 3. The Series 51 bar, first made in 1961, contains 31 elements and represents the practical limit of

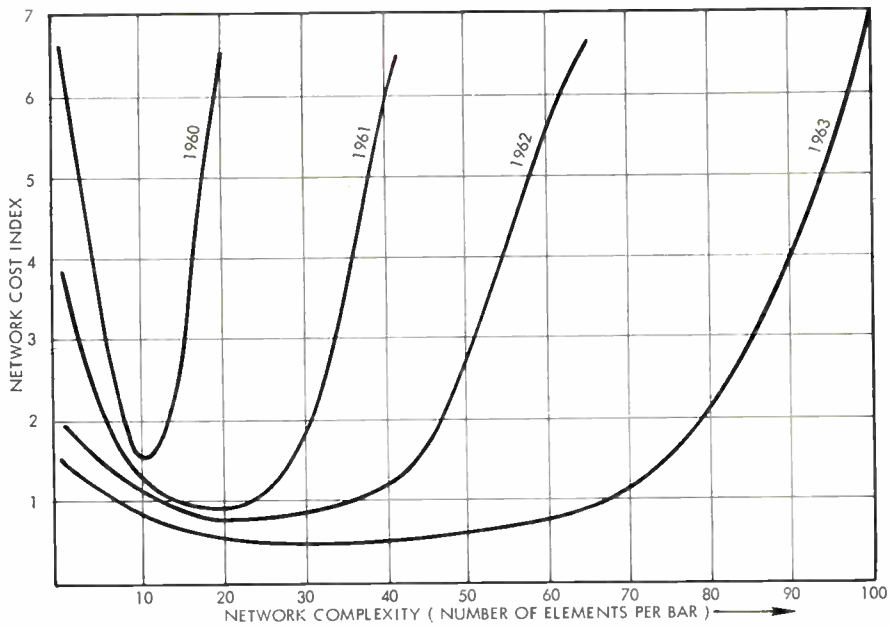


Fig. 2: Chart shows the effect of network complexity on the cost per circuit.

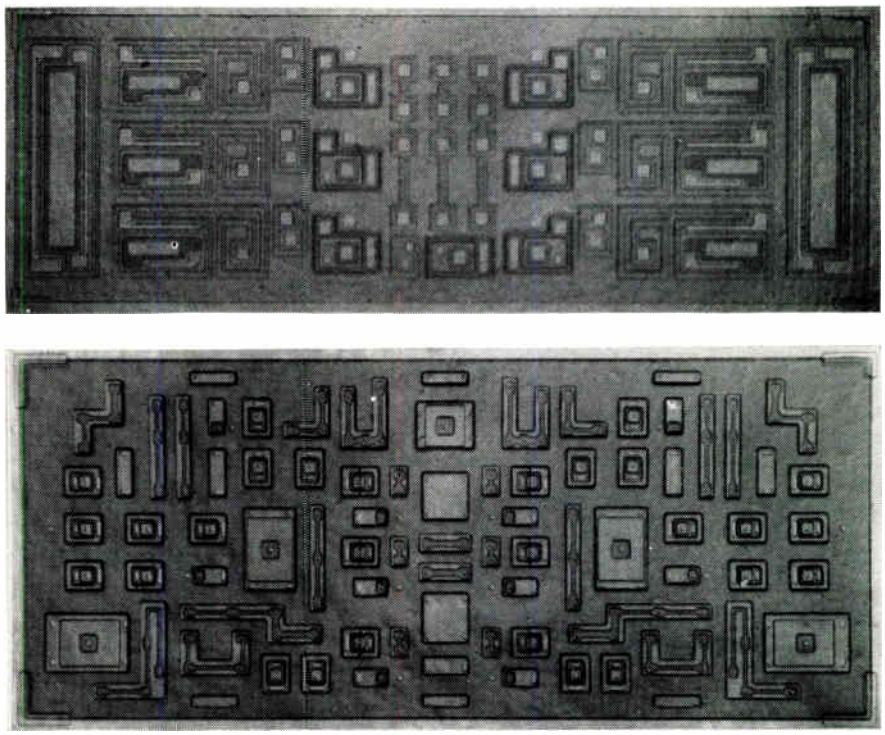


Fig. 3: Photographs of Series 51 (top) and 53 network bars just before metallic interconnections are deposited. Two bars represent a span of only two years.

complexity at that time. The Series 53 bar produced in early 1963 contains 69 elements, representing a two-fold increase in complexity on a smaller network bar only 18 months later.

While describing the changes in cost vs complexity over time, Fig. 2 also reveals that along the flat portion of the curve network cost is *not* proportional to complexity. Today, networks capable of performing four or five complete circuit functions (60 to 70 elements per bar) can be produced at costs comparable with those of simple networks performing only one or two circuit functions (20 to 30 elements per bar). This fact is the basis for the inherent economies of multi-function networks: Below a steadily advancing limit, the cost of a network is *not* proportional to its complexity.

Integrated Circuit Prices

Multi-function networks bring the

World Radio History

effective cost of integrated circuits to a level where they are now competitive with discrete-component circuitry in most applications. Consider that, up to a certain point, the complexity of a network may be increased without a proportional increase in its cost. There will, in fact, be only a slight increase in network cost. However, the number of circuit functions a network may be capable of performing will vary directly with its complexity. Therefore, a network capable of performing several circuit functions offers the lowest possible cost per circuit function.

Fig. 4 demonstrates the inherent economies of multi-function networks. This figure shows that the cost (value) of a gate is constant when considered in a discrete-component form ($5 per assembled gate is a typical value for military systems). Assuming no price breaks, four gates cost four times as much, or $20. The next two lines indicate that although a simple single-gate network may cost $10, the complexity of this network may be increased to include four gates with an increase in cost of only 20% to $12. This results in an effective cost reduction from $10 per gate to $3 per gate.

Fig. 5 summarizes both the short- and long-term effects of multi-function networks on the current integrated circuit price trend. Process cost reductions for any semiconductor product come gradually when —as is true for integrated circuits— the early, steep portions of the cost curve have been passed. Such reductions result from improved process controls, improved labor efficiency, and mechanization—all of which require the gradual accumulation of experience.

Circuit Cost Structure

An examination of the integrated circuit manufacturing cost structure verifies that network cost increases only slightly with increased complexity. A direct comparison between the manufacturing costs associated with a network containing four 2-input gates and a simple network containing one of the same gates is shown in Fig. 6. The manufacturing costs of these semiconductor networks can be broken into two distinct areas—slice processing and network assembly.

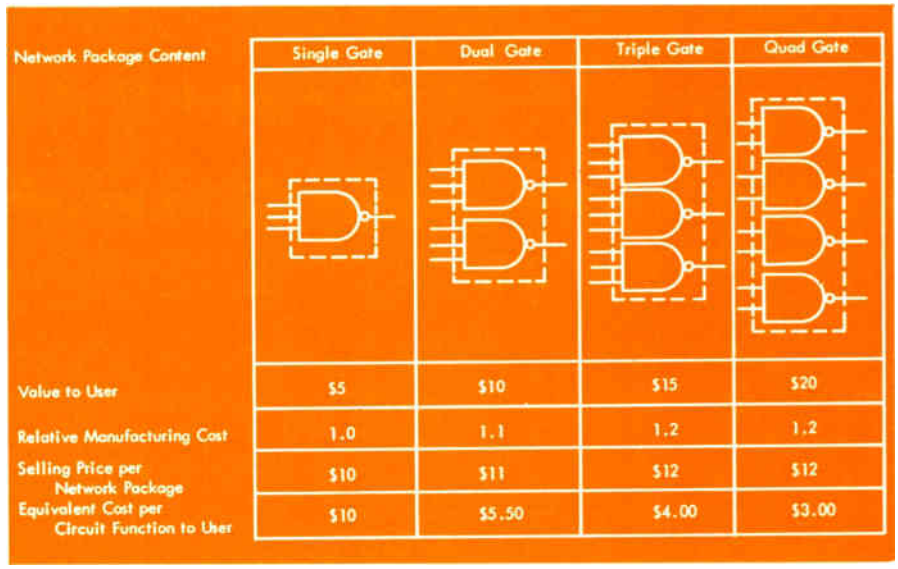
Slice-processing costs are almost a direct function of network complexity since, during this early part of the process, slices (each of which contains many network bars) are handled individually. Thus, cost are accumulated per slice. Cost per slice remains constant regardless of network complexity, but the number of networks per slice decreases directly with increasing network complexity. Therefore, slice preparation costs per network vary *directly* with network complexity.

Assembly costs are almost insensitive to variations in complexity, since these costs involve handling, mounting, inspecting, and capping each individual network, regardless of its complexity or size. Even the probe and final electrical-test costs are insensitive to complexity, since automatic test equipment is used.

The major manufacturing costs (80 to 90%) of integrated circuits are in the assembly steps which are relatively insensitive to network complexity. Multi-function networks prorate these dominating costs over several circuit functions, reducing the effective cost per circuit function.

Effect on System Costs

The impact of multi-function net-



Network Package Content	Single Gate	Dual Gate	Triple Gate	Quad Gate
Value to User	$5	$10	$15	$20
Relative Manufacturing Cost	1.0	1.1	1.2	1.2
Selling Price per Network Package	$10	$11	$12	$12
Equivalent Cost per Circuit Function to User	$10	$5.50	$4.00	$3.00

Fig. 4: Effect of multi-function networks on cost per circuit function.

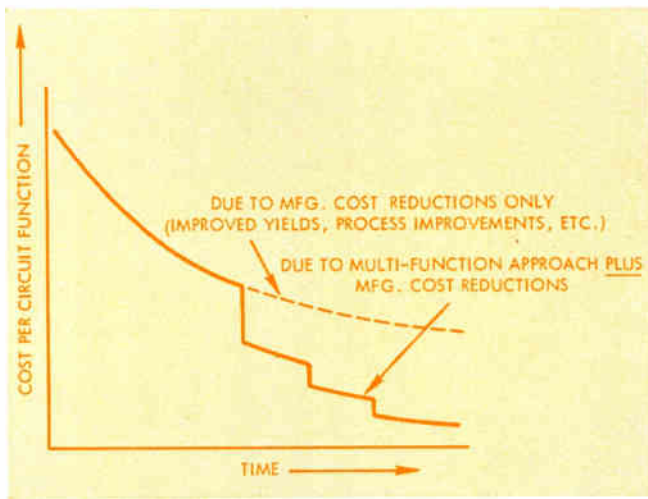


Fig. 5: Chart of current integrated-circuit price trends, showing downward step-function effect on multi-function networks.

World Radio History

works on a system may be shown by analysis of an actual system's functional needs. Fig. 7 lists the logic requirements for system A, with two means of filling these—one using only simple network gates and another using multi-function networks. The system requirement for 3948 identifiable logic functions can be met using 3810 networks if simple gates are used, or 2873 networks if multi-function gates are used. The use of these multi-function networks reduced the cost of the integrated circuits used in this system by nearly 25%. Also, a large number of interconnections are saved, thereby reducing assembly costs while improving reliability. Fewer circuit boards are required, thus reducing board, connector, and other hardware costs.

System A is an actual, typical system chosen to describe the practical advantages of multi-function networks. Of course, other types of systems would not make such extensive use of the EXCLUSIVE OR function and may, instead, use large numbers of 2-, 3-, 4- and 5-input gates.

Custom Networks

Under certain conditions, it may be desirable to supplement available catalog networks with custom multi-function networks. Naturally, the objective of such an approach would be to optimize the use of the networks to fulfill a system's requirements. A successful example of this approach is shown in the analysis of system B, Fig. 8.

System B requires 107,643 logic circuits (about 1,000,000 discrete components). Using simple networks, the system can be implemented with 67,282 network packages. However, multi-function networks reduce this by 32% to 41,848 packages. A total reduction of 65% to 23,278 packages can be done through use of custom network (Fig. 9), used with catalog networks. The significance of these comparisons can be seen when it is remembered that catalog and custom multi-function networks are only slightly higher in cost per package than simpler networks. As noted previously, there are also savings in circuit boards, hardware, and other materials and assembly. Again, reliability is improved with every reduction in parts and connections.

The criteria for consideration of custom networks to supplement catalog networks in a system is simply that the economic benefits realized must offset the initial set-up cost. This generally implies that the configuration to be provided in the custom network must be used in relatively large volumes.

There are two ways to achieve a custom network. One approach is to design a completely new network bar for specific use. This generally involves the design of new diffusion masks, interconnection masks, and bonding patterns, and may involve completely new diffusion schedules.

Another approach is through the Master Slice concept to obtain "semi-custom" networks. This approach takes established network bars in high-volume production, containing large numbers of circuit elements, and interconnects them in the desired configuration simply by changing the internal interconnection mask. The custom network shown in Fig. 9 is a Series 53 Master Slice variation which would be more than justified by the 18,570 such networks used in a single version of System B.

Completely custom networks offer eventual lowest cost per function, offset by considerable design and set-up time and cost. Only larger volumes warrant this approach.

(Continued on following page)

Fig. 6: Relative manufacturing cost comparison of simple and multi-function semiconductor networks, showing why networks cost little more than simple versions.

MANUFACTURING STEP	ONE GATE PER NETWORK	FOUR GATES PER NETWORK
		
	320 NETWORKS PER SLICE 	80 NETWORKS PER SLICE 
SLICE PROCESSING  ● Lap and Polish ● Image Transfers ● Etchs ● Diffusions ● Metallization ● Inspections	5 COST UNITS PER NETWORK BAR	20 COST UNITS PER NETWORK BAR
NETWORK ASSEMBLY  ● Scribe into Bars ● Mount Bar in Header ● Bond to External Leads ● Seal ● Test	95 COST UNITS PER NETWORK BAR	100 COST UNITS PER NETWORK BAR
RELATIVE COST PER NETWORK	100	120
RELATIVE COST PER CIRCUIT FUNCTION	100	30

World Radio History

MULTI-FUNCTION CIRCUITS

Summary

Multi-function networks, now possible because of improved process technology, offer lowest integrated circuit cost per circuit function. Since electronic systems have fixed functional requirements, the system designer may realize impressive cost reductions with currently available multi-function networks. The economic advantage available today from these networks make integrated circuits truly competitive with discrete component circuits for most applications.

The simple network is no longer and never again will be more economical than multi-function networks. In fact, as process technology advances, there will be continued incentives to obtain more and more circuit functions per network. The logical extension of the multi-function concept will be carried far beyond the networks described in this paper.

Fig. 7: Analysis of a system, showing needs and how choice of simple vs. multi-function networks affects number of packages.

SYSTEM A

FUNCTIONAL REQUIREMENTS		USING SIMPLE NETWORKS		USING MULTI-FUNCTION NETWORKS	
FLIP-FLOPS	2330	FLIP-FLOPS	2330	FLIP-FLOPS	2330
EXCLUSIVE OR	480	DUAL 2-INPUT GATES	720	DUAL EXCLUSIVE OR	240
4-INPUT GATES	72	4-INPUT GATES	72	DUAL 4-INPUT GATES	36
2-INPUT GATES	756	DUAL 2-INPUT GATES	378	QUAD 2-INPUT GATES	189
BUFFER/INVERTERS	310	BUFFER/INVERTERS	310	QUAD BUFFER/INVERTERS	78
	3948		3810		2873

25% REDUCTION IN PACKAGE COUNT

Fig. 8: Another system showing functional needs and how number of packages is affected by the choice of networks.

SYSTEM B

Functional Requirements		Simple Semiconductor Network Version		Catalog Multi-Function Semiconductor Network Version		Catalog Plus Custom Multi-Function Semiconductor Network Version	
Shift Registers	334	Flip-Flop/Shift Register/Counter	19,135	Flip-Flop/Shift Register/Counter	19,135	Flip-Flop/Shift Register/Counter	565
Flip-Flops	18,763					Buffer/Inverter	1,421
Binary Counters	38	Buffer/Inverters	5,684	Buffer/Inverters	1,421	Master Slice Network	18,570
Buffer Drivers	5,227	Logic Gates		Logic Gates		Logic Gates	
Logic Gates		Dual 3-Input	42,232	Quad 2-Input	20,981	Quad 2-Input	2,411
Inverters	455	5-Input	231	Triple 3-Input	150	Triple 3-Input	150
2-Input	81,122			Dual 3-Input	45	Dual 3-Input	45
3-Input	539			Dual 5-Input	116	Dual 5-Input	116
4-Input	231						
Half-Adders	934						
	107,643		67,282		41,848		23,278

37% Reduction in Packages

65% Reduction in Packages

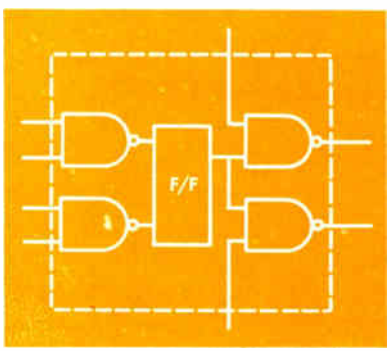


Fig. 9 (left): Logic diagram of a custom multi-function network made from Series 53 by changing interconnection pattern.

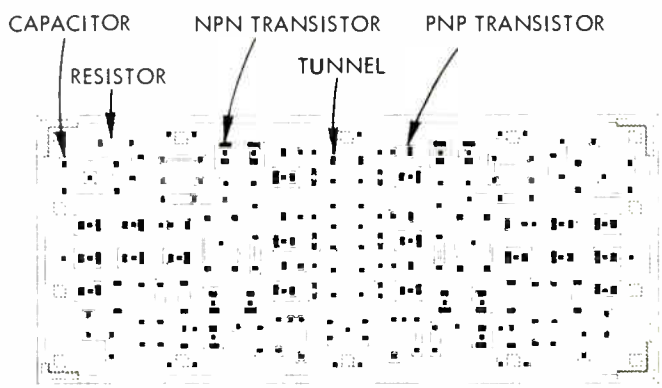


Fig. 10 (right): Outline drawing of Master Slice bar with elements listed.

World Radio History

ELECTRONIC INDUSTRIES
STATE-OF-THE-ART
FEATURE

NEW DEVELOPMENTS IN INTEGRATED CIRCUITS

What are integrated circuits? What are their characteristics, advantages and applications? Are these devices now available from stock? Are their prices competitive with equivalent discrete component assemblies? What prompted the development of linear integrated circuits, and what is their future? These and other pertinent questions are answered here.

By GEORGE L. POWERS and ROBERT J. WIDLAR
Fairchild Semiconductor, Mountain View, Calif.

MONOLITHIC INTEGRATED CIRCUITRY is a form of construction wherein transistors and resistors are made on a single substrate and interconnected with deposited-metal patterns. The technology used is similar to that developed over the past few years in the manufacture of Planar transistors. With this method hundreds of circuits can be processed at once on a single silicon wafer with nearly the same steps as are needed to make individual transistors. Hence, complete circuits can be produced at a cost approaching that of an individual transistor, providing a reasonable number of the circuits on the wafer are useable.

Improved manufacturing methods and process control have brought the price of planar transistors down to where they are cost-competitive with any other type of active device. Integrated circuits are developing along the same lines. Increased manufacturing yields have permitted price reductions to the point where integrated circuits can now be made at a lower cost than circuits assembled using discrete components. This is true for almost any buildable circuit in large volume and particularly true for well-accepted standard circuits in any volume. Other advantages of integrated circuitry are that there is less total testing of parts, a great reduction in equipment size, and a big increase in reliability.

In this article, the characteristics and uses of some standard integrated circuits will be discussed. The devices described are now available with delivery from distributor stock at prices competitive with equivalent discrete-component assemblies.

* * *

Two distinct families of digital logic circuits have evolved at Fairchild Semiconductor. For high-speed, low cost digital systems, Standard Micrologic has been used for over four years. A similar family of low power circuits dubbed Milliwatt Micrologic has been designed for uses in which minimum power consumption is essential. Basic circuit of each of these families is shown in Fig. 1.

Since only resistance values differ, these two are hardly separate families. In fact, they are mutually compatible and may be intermixed. The most popular devices of these two families are now being offered as Industrial Microcircuits.

(Continued on following page)

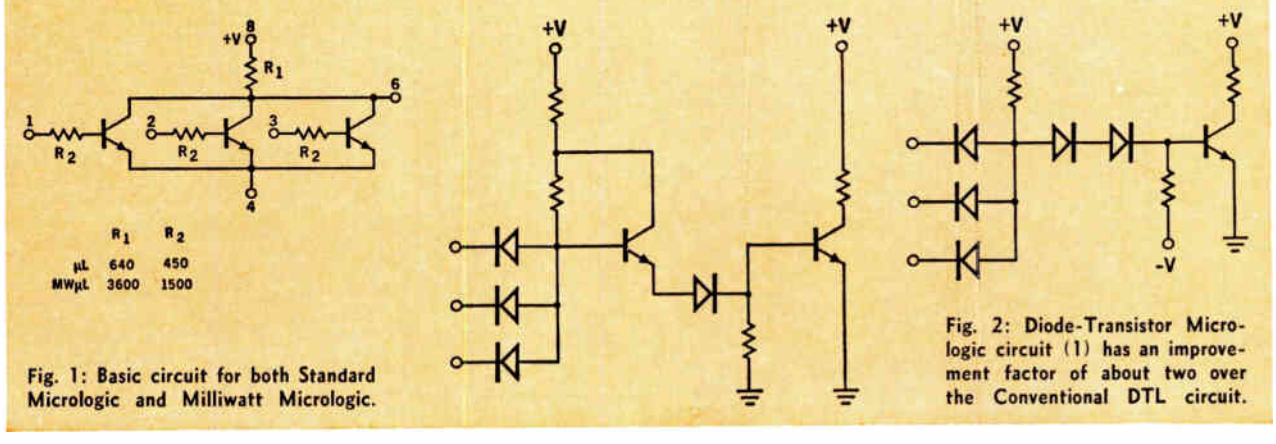


Fig. 1: Basic circuit for both Standard Micrologic and Milliwatt Micrologic.

Fig. 2: Diode-Transistor Micrologic circuit (1) has an improvement factor of about two over the Conventional DTL circuit.

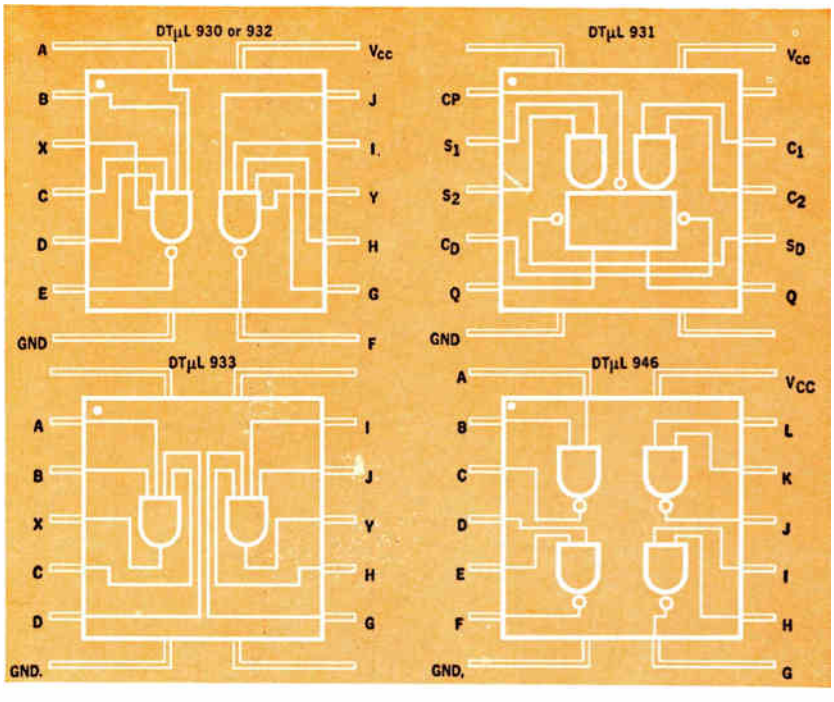
World Radio History

Our most recent development in digital integrated circuits is Diode-Transistor Micrologic. DTμL is a circuit of moderate speed, high fan-out capability, and good noise immunity features. Superior performance is achieved through a modification of a normal DTL circuit, Fig. 2. In this circuit, one of the offset diodes has been replaced with a transistor whose collector is returned to a tap on the input pull-down resistor. This reduces the beta requirement of the output transistor for a given fan-out or increases the fan-out for a given transistor beta. The improvement factor is about two.[1] A subsidiary benefit is that top performance does not need a negative bias supply as normal DTL does. The entire DTμL line is shown in Fig. 3.

The Clocked Flip-Flop is unique in two respects among DTL circuits. First, it does not use capacitors, charge storage devices or any other circuit-dependent delay for triggering. Instead, it relies upon trigger levels, and thus is independent of rise or fall times or pulse widths. Any signal having two distinct levels in the proper range is an adequate trigger.

The other feature of this device is the AND gate inputs. A designer may cross-couple one set of these and create the so-called J-K mode which is valuable in binary counters. He may also use them independently to achieve a function peculiar to his own particular uses. The DTμL family is rounded out with a Dual 4-input NAND/NOR Gate, a Quad 2-input NAND/NOR Gate, a Dual 4-input Buffer-Driver, and a Dual 4-input Extender. The Input Extender is used when a fan-in greater than four is needed.

Fig. 3: The entire DTuL family is shown here.



The Buffer Driver is used to provide high fan-out capability or to derive high capacitance loads.

For very high capacitance loads the TTμL-103 Dual 4-input Gate or the TTμL-104 8-input Gate is useful. Propagation delays of 50 nsec over the military temperature range of −55°C to +125°C are typical of either of these gates when loaded with 600 pf and fanned-out to 14 similar gates. Good noise immunity is also characteristic. Developed for the TFX program, these circuits are wholly compatible with the Diode Transistor Micrologic family.

Linear Circuits

Initial development of integrated circuits was concentrated primarily on digital uses. It was felt that digital circuits were more tolerant of the limitations of monolithic construction and that they could be more easily standardized for volume production. But, improved process control and increased manufacturing yields and the ready acceptance of integrated circuits has prompted the development of linear integrated circuits. Early attempts in this line were encouraging. Results showed that carefully designed devices with reasonable specs could be made with little more difficulty than a digital circuit.

The first standard circuit demonstrating this is the μA702 operational amplifier.[2] The μA702 performs a complex amplifying function, yet it is about the same size as a ZN1613 Planar transistor. It uses processing nearly identical to that proven with digital circuits, and it was introduced at prices equal to those of comparable digital devices. A circuit design is used which makes use of the advantages of monolithic construction and avoids many of the limitations.

The μA702 is a high gain, wideband, dc amplifier. It has a differential input and a single-ended, zero referred output. It was intended to be a general-purpose device to cover a wide range of uses. It features low dc offset and low drift; and it can be operated over a wide range of supply voltages, to fit varying needs, with no degradation in its usefulness as a dc amplifier.

The operational amplifier is a versatile tool in the design of linear, or analog circuits. It has a range of use much wider than as a simple feedback amplifier. Many useful circuits can be found in textbooks on analog computer methods, [3] for which the operational amplifier is a basic building block. The broad scope of use of this device will now be shown by specific examples of practical circuits.

World Radio History

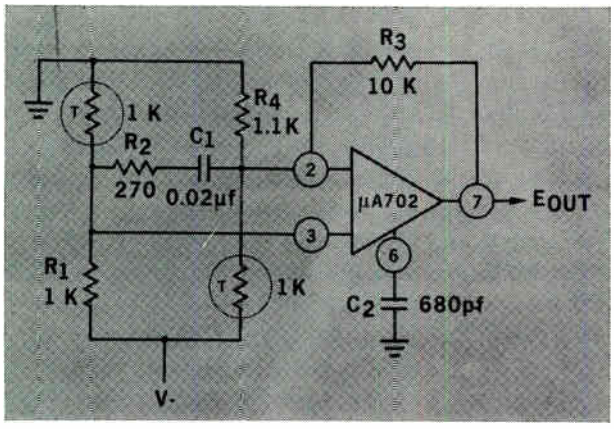


Fig. 4: Amplifier for thermistor bridge.

Applications

One of the largest potential uses for a monolithic operational amplifier is as a signal conditioner for a telemetry system. One such use is shown in Fig. 4. Here the differential output of a thermistor bridge is amplified by 10. A single-ended output is obtained such that the amplifier output is zero when the bridge is balanced. In the circuit shown, the null drift of the bridge due to the amplifier will be less than 3mv over the temperature range of −55° to +125°C.

An amplifier circuit for a piezoelectric transducer is given in Fig. 5. The voltage gain of this circuit is 2, while the input impedance is over 5 MΩ. Lower cutoff frequency of the amplifier, as shown, is 1 cps.

Fig. 6 gives the schematic for a servo preamplifier or position indicator. Solar-cell sensors are used. The circuit shown has a sensitivity of 50v/μa. The amplifier responds to the short-circuit output current of the sensors since the voltage across them is kept less than 10mv.

Examples of the μA702 being used as a video preamplifier are given in Fig. 7 and 8. Fig. 7 shows a 40db amplifier for a tape head, drum-read head or core sense line. The circuit has a 10mc bandwidth and an input capacitance of less than 2pf. The input resistance is essentially that of the terminating resistor, R2; and the output resistance is about 10Ω.

The circuit in Fig. 8 is a high speed photodiode amplifier. Sensitivity is 10v/ma and the bandwidth is over 10mc. The input impedance is less than 10 while the output impedance is about 1Ω. Sensitivities of 100v/ma with bandwidths greater than 4mc can be obtained with this seutp.

The μA702 can also be used as a wideband ac amplifier, as a high pass or low pass amplifier or as a bandpass amplifier by proper choice of the feedback elements. As an example, a 1kc bandpass amplifier with a 40db gain is drawn in Fig. 9. It uses a twin "T" notch filter in the feedback loop to obtain the bandpass characteristic. Gain at the center frequency is essentially determined by R1 and R3.

Often in many circuits such as rectifiers, clippers,

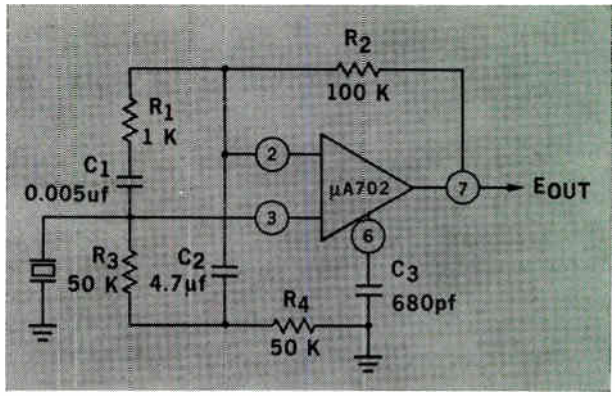


Fig. 5: Amplifier circuit for a piezoelectric transducer.

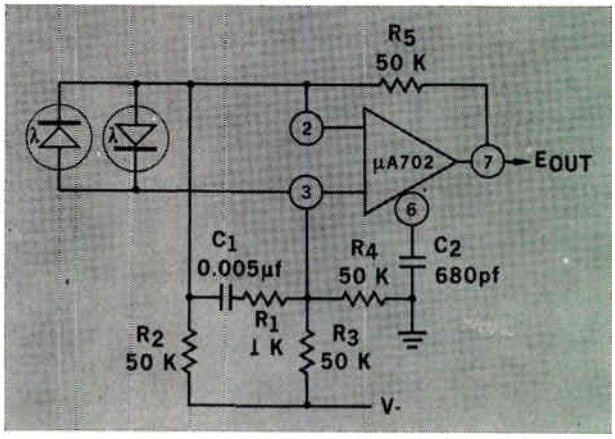


Fig. 6: Preamplifier for servo system using solar cell sensors.

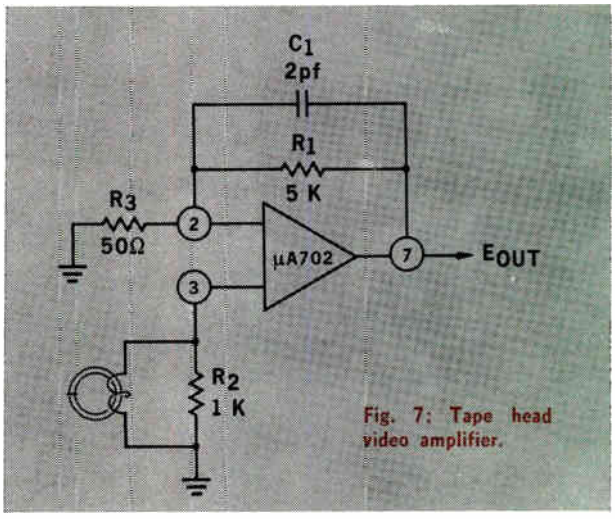


Fig. 7: Tape head video amplifier.

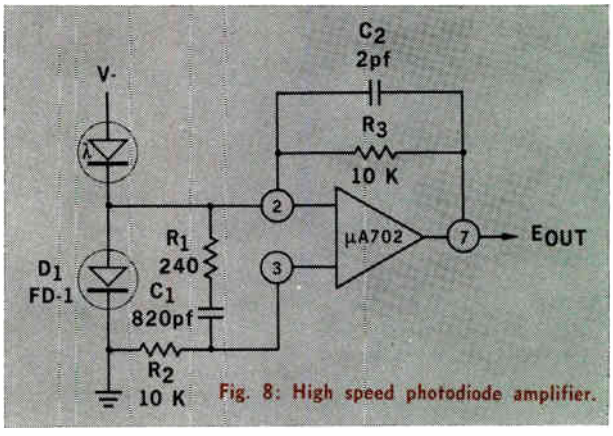


Fig. 8: High speed photodiode amplifier.

World Radio History

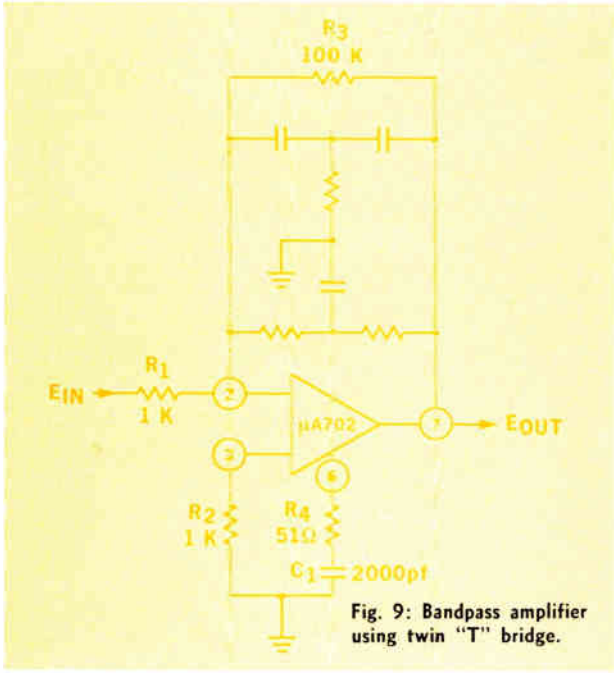


Fig. 9: Bandpass amplifier using twin "T" bridge.

clampers and peak detectors where diodes are called for, diode threshold voltage is a big problem. This is particularly true in low level circuits. In these cases an operational amplifier is quite useful in that it can be used to reduce the effective threshold of the diodes by several orders of magnitude. Fig. 10 gives an example of this. Output of the circuit is a positive dc voltage which is proportional to the peak-to-peak value of the input waveform. Threshold voltage of the silicon diodes is divided by the open-loop gain of the amplifier so it is less than 1mv. Another diode circuit which is used is a precision clamper. It gives an inverted, positive going output signal which is clamped to the dc reference voltage supplied to the amplifier.

Another useful diode circuit is the precision full-wave rectifier or absolute value generator whose output is the positive absolute value of the input voltage.

A circuit which further illustrates the broad scope of use of the operational amplifier is the phase detector in Fig. 11. Output is a function of the phase displacement between the signal and reference voltages. Positive and negative outputs are obtained for phase lead and lag.

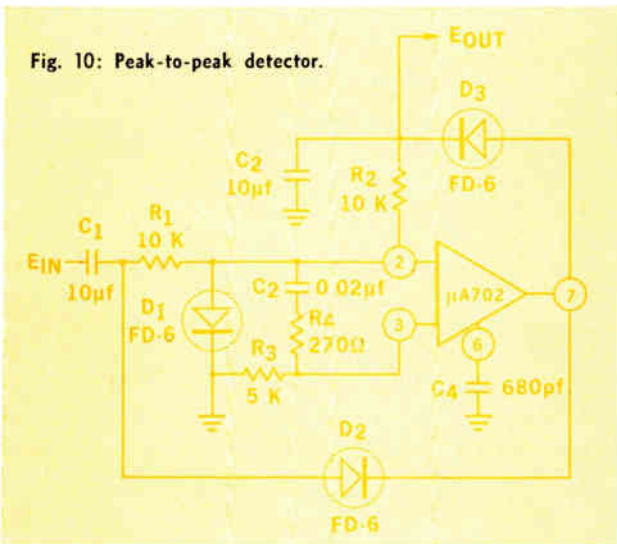


Fig. 10: Peak-to-peak detector.

Future Circuits

Total integration of linear systems is further off than the digital counterparts both because the limits of current technology make impractical the integration of certain components and because the use of some external parts, which determine overall performance, greatly increases the flexibility of a particular device. But, the circuits given show that, even in linear circuits, complex designs can be built with monolithic devices at a large savings in cost, complexity and size. This should become even more apparent as linear product lines are expanded. Circuits that appear likely for the near future are high-speed differential comparators, large capacity analog commutators, i-f/r-f amplifiers, wideband video amplifiers, etc.

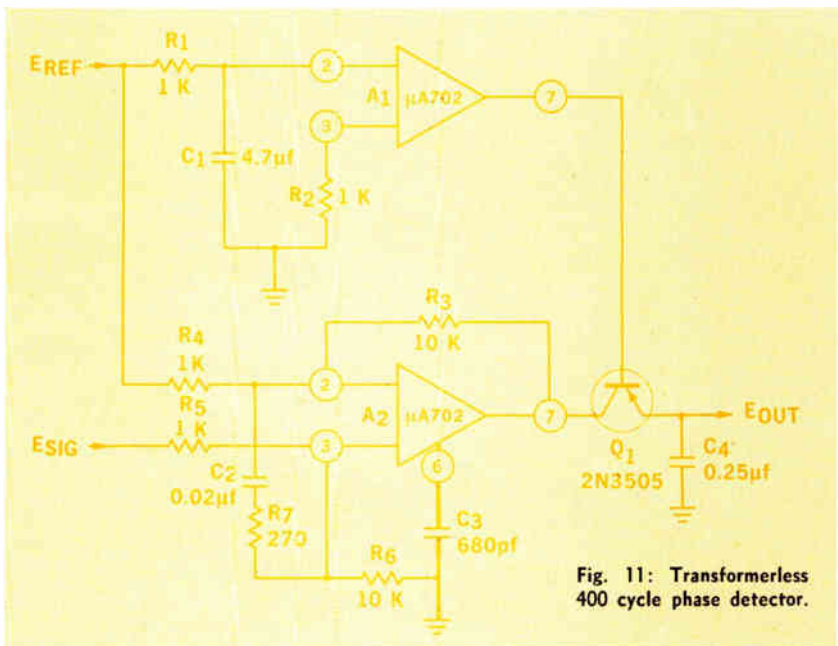


Fig. 11: Transformerless 400 cycle phase detector.

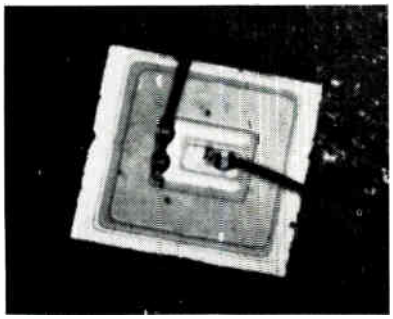
References

1. Bohn, R., "Diode Transistor Micrologic for Digital Applications," *Electronic Design*, Aug., 1964.
2. Widlar, R. J., "A Monolithic Operational Amplifier," *Fairchild Semiconductor APP-105*, Aug., 1964.
3. Jackson, A. S., *Analog Computation*, McGraw-Hill, New York 1960.

• A REPRINT of ANY ARTICLE in this issue is available from ELECTRONIC INDUSTRIES Reader Service Department.

World Radio History

WHAT'S NEW



This complete differential amplifier, which has 6 transistors, measures 0.625 x 0.375 in. and is less than 100 mils thick.

MICRO DIFFERENTIAL AMPLIFIER WITH HIGH DC STABILITY

CLOSE MATCHING OF INPUT TRANSISTORS and the use of npn and pnp transistors in a unique circuit have produced a very stable microelectronic differential amplifier. The manufacturer, General Instrument Co., Semiconductor Group, Hicksville, L. I., N. Y., states the unit has a dc stability of 5 μv/°C and a common-mode rejection of 100db.

The circuit, PC-201, combines 7 silicon transistors, 6 multiple resistors, and 1 capacitor on a 0.570 x 0.325 substrate. The input transistors have an initial V_{BE} match of 1 mv, as compared to the industry standard of 10 mv. The single-ended open loop gain is 73db, and the differential input is 200KΩ.

The unit is designed for critical operational-amplifier and transducer-amplifier uses.

GEMINI/AGENA COORDINATOR

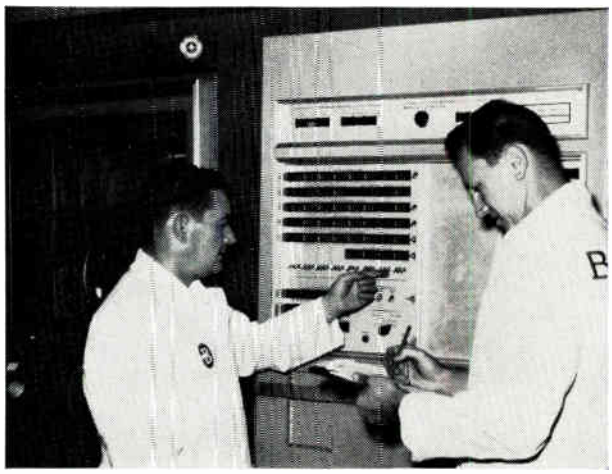
A BURROUGH'S COMPUTER will play an important role in the Gemini program. The system will first guide the Agena target into orbit, and then guide the Titan launch vehicle to put the Gemini on a path for mating with the Agena.

Two arrays of equipment have been developed and added to the computer for the Gemini program. These systems, called the Data Exchange Unit (DEU) and Flight Monitor Recording Console, will enable the computer to provide the data required by the program.

Before and during flight of the Gemini, the DEU will feed position data into the inertial guidance system of the vehicle. Thus oriented, the system will have a reference with which to compute the spacecraft's position prior to and during its rendezous with the orbiting Agena.

The Flight Monitor Recording Console includes recorders which monitor 26 key performance characteristics of the launch vehicle. Data such as engine deflection, pitch and yaw and the status of the flight controls are received by telemetry from the Titan during launch. Should any malfunctions appear, the Mission Control Center will be alerted so corrective action can be taken.

The DSU will function as a central electronic distributor for communication between the ground-based guidance computer, the Gemini spacecraft, the Titan vehicle and NASA.



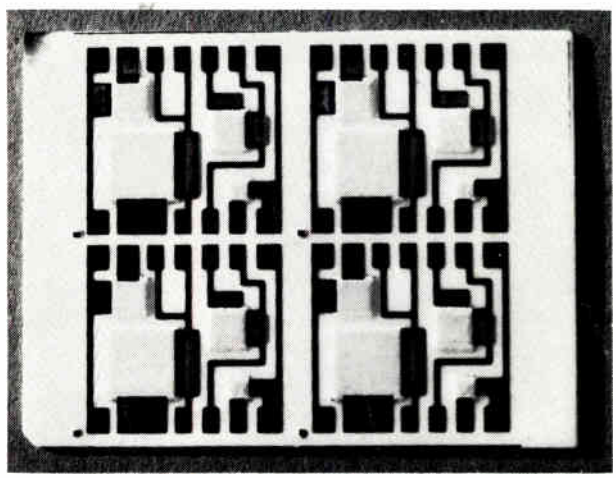
THIN-FILM CAPACITORS

A HEREMETICALLY SEALED, THIN-FILM CAPACITOR has been developed to replace attached discrete units or vacuum-deposited silicon-monoxide film units previously used in microcircuits. The units have a 50-volt rating and a capacitance range between 100 and 5000 pf.

The capacitor, developed by Corning Glass Works, Corning, N. Y., has a niobate-glass dielectric. This glass changes under processing temperature into a crystallized substance with a dielectric constant of about 600. Capacitance is about 80,000 pf/sq. in. active area. The unit may be placed in series or parallel under one dielectric pattern if the dielectric area is less than 0.250 sq. in.

The voltage rating of 50 volts from −55° to +125°C is consistent with use of transistor circuitry. The capacitor is expected to conform with Mil-C-11015C at this rating.

Thin-film capacitors replace attached discrete or vacuum-deposited silicon-monoxide film units on microcircuits.



World Radio History

Message processing in the system described here includes queuing for display on electronic consoles such as the one shown above.

COMPUTER-BASED MESSAGE SWITCHING CENTERS

By FRED G. WOLFF,
Deputy Manager,
Switching Center Programs,
Great Valley Laboratory
Burroughs Corporation,
Defense and Space Group,
Paoli, Pa.

Message switching, once done by manual relaying, has evolved to the point where modern high-speed computers are being used. This article describes the development of message switching and uses as an example of a modern system one which is soon to be installed. The future of these systems is also discussed.

COMMUNICATIONS SWITCHING CENTERS have long been recognized as an obvious use for high-speed computers. Full duplexing of normal computers, with rapid switchover provisions, has been used to assure the constant availability needed by these uses. Recently developed schemes for multicomputer/-multiprocessing system organization and automatic self-scheduling have reduced downtime to minutes per year in continuous operation. These schemes have greatly expanded usefulness of computers in critical message switching installations.

This article describes the evolution of the modern message switching center and its implementation with modern computing systems. A soon to be installed system is used as an example.

* *

Small electrical communications systems can efficiently use point-to-point circuits. But, as more and more terminals are added, the number of circuits becomes costly and cumbersome, and some method of switching must be used. Two alternatives are *circuit switching* and *message switching*. The latter is also called *store-and-forward switching*.

F. G. Wolff

We are all familiar with the largest circuit switching network in the world—the telephone system. Traffic is passed directly from initiating terminal to destination terminal, but only after a through connection (or series of connections) has been established from one terminal to the other.

We also daily encounter the largest store-and-forward message switching network in the world—the U. S. Mail. In contrast to circuit switching systems, traffic moves first from the originating terminal to a switching center, later to another switching center, and so forth, until it finally arrives at the destination terminal. In the telephone system, delay occurs in a single lump prior to transmission. In the postal system, small increments of delay occur at several points enroute.

Message switching need not be slower than circuit switching, especially when circuit switching delays due to establishing connections, busy trunks, etc., are considered. Moreover, with message switching, priority systems can be established to ensure immediate handling of urgent messages.

Chief advantage of message switching is its ability to average trunk loading. This allows more traffic

World Radio History

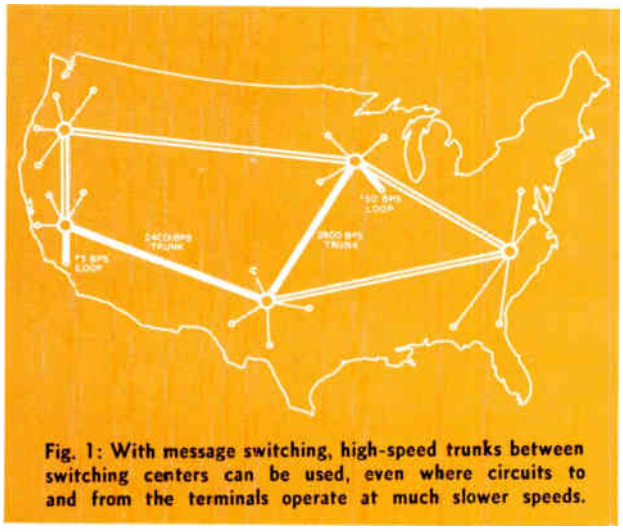


Fig. 1: With message switching, high-speed trunks between switching centers can be used, even where circuits to and from the terminals operate at much slower speeds.

to be handled over a given network, or the same volume of traffic to be handled by a more economical network. Also, high-speed trunks between switching centers can be used, even where circuits to and from terminals operate at much slower speeds, Fig. 1. In fact, terminals need not operate at the same speed to exchange traffic, an obvious requirement for circuit switching.

Many conveniences and services not possible with circuit switching are also available: There is no need to wait until a through connection to the destination is established; multiaddress messages need be sent to the switching center only once; and a number of statistical and retrieval services can be provided.

Development of Message Switching

Originally, message switching was done by manual relaying; an operator at the switching center would read an incoming message and enter the message into the keyboard of a teletype machine connected to the addressee (or to another switching center).

This cumbersome, error-prone method was soon replaced by the still popular torn-tape relay. Here messages are received in the form of punched paper tape and are torn off and hand-carried to tape readers connected to appropriate addresses or switching centers.

More complex message switching centers use electromechanical cross-office switching methods. In this approach a message is stored in a paper-tape loop at the incoming equipment until it can be electrically switched across the central office to the appropriate output equipment. Here it is again stored in a paper-tape loop pending transmission.

Most recently, the completely electronic message switching center has evolved, using digital data processors. In the computer-based switching center, messages are stored and processed in electrical form until transmitted to destinations. *(Continued)*

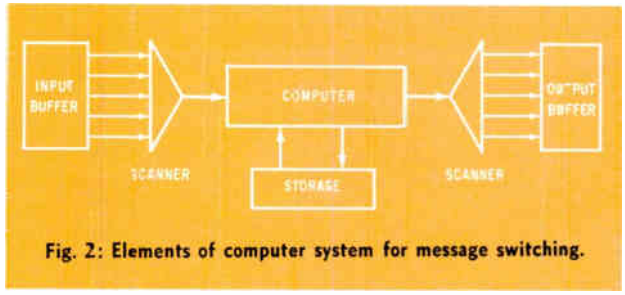


Fig. 2: Elements of computer system for message switching.

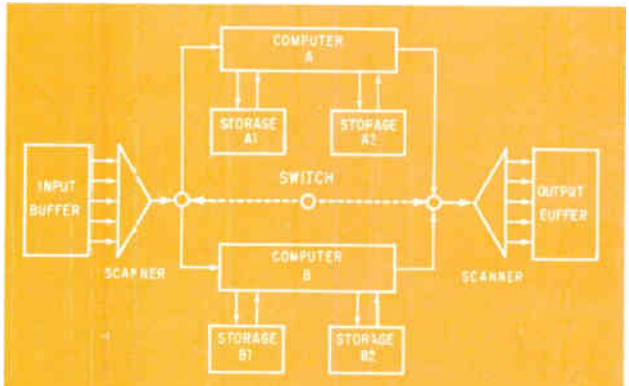


Fig. 3: Duplex computer system approach.

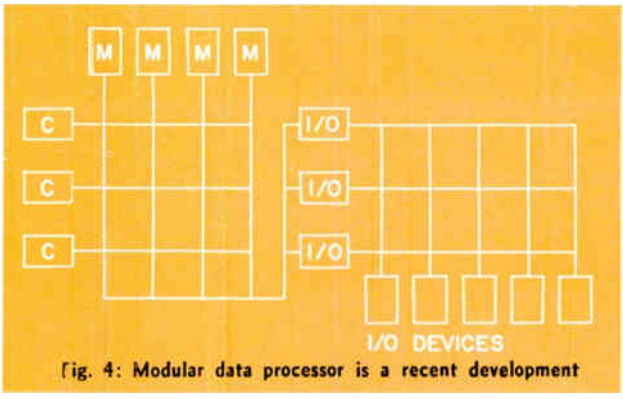


Fig. 4: Modular data processor is a recent development

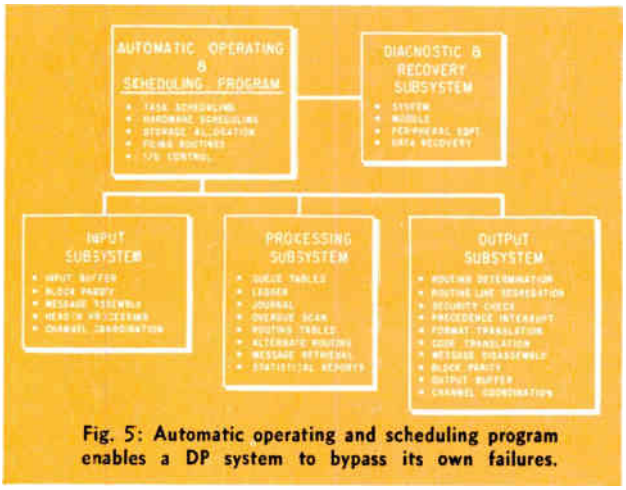


Fig. 5: Automatic operating and scheduling program enables a DP system to bypass its own failures.

• A REPRINT of ANY ARTICLE in this issue is available from ELECTRONIC INDUSTRIES Reader Service Department.

World Radio History

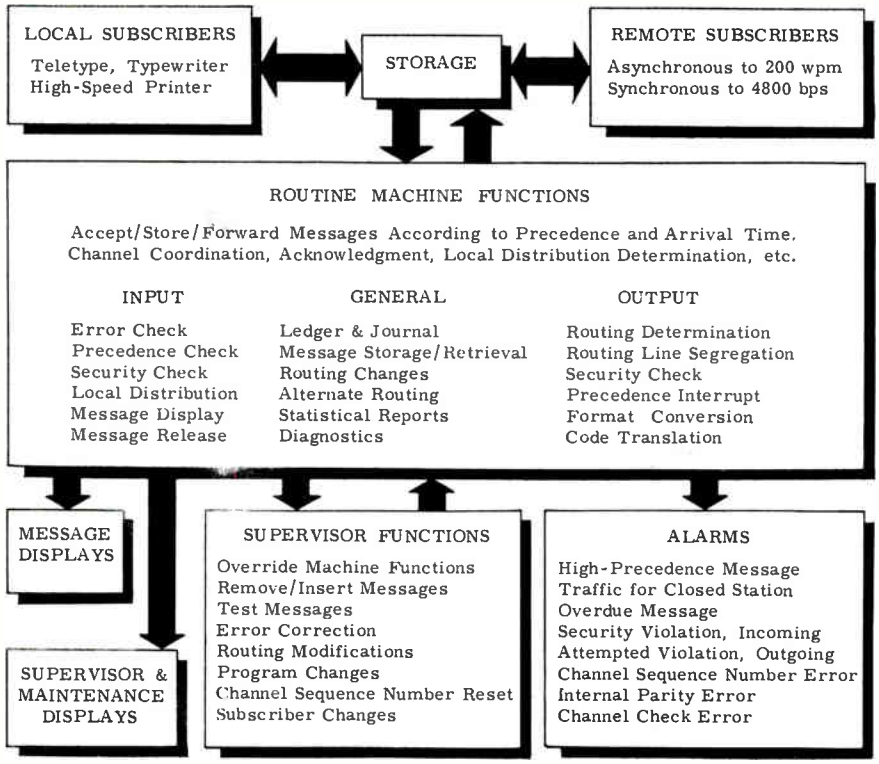
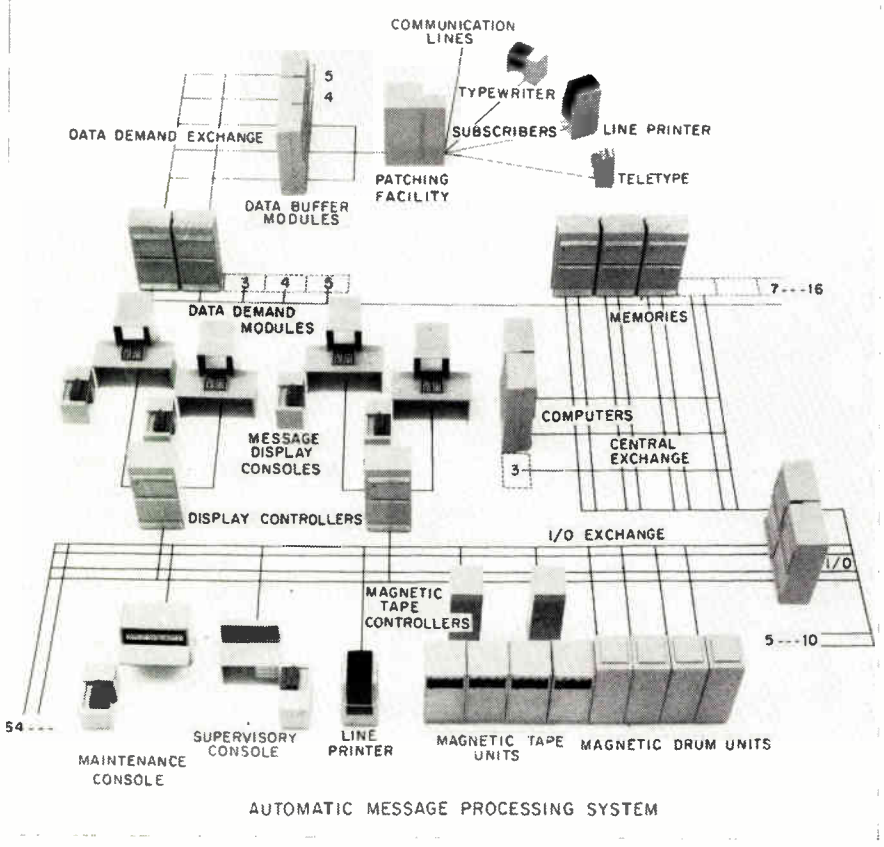


Fig. 6: Functional diagram of the Automatic Message Processing System.

Fig. 7: The Automatic Message Processing System is based on the Burroughs Modular Data Processing System. For this application the D825 is arranged as in the diagram above.



Elements of Message Switching

Data processors for message switching center uses vary widely in their internal organization but, in general, incorporate four major functional areas: A central computer, bulk storage, line scanning, and line compatibility and buffering, Fig. 2.

The *central computer* performs the processing functions needed by the message switching task. These are queuing, routing, storage allocation, code conversion, record-keeping, response to editing by human monitors (entered via display consoles) and generation of statistical reports.

Bulk storage, in the form of typically magnetic drums or disc films supplemented by magnetic tape, is used for the storage of in-transit messages. It is also used for the accumulation of historical message files and reference data.

Communications circuits represent an essentially uninterrupted stream of data flowing at relatively slow speed; the fastest practical signaling rate over voice-grade lines is now 2400 bits per second (BPS). Rates on even wideband channels now in use rarely exceed 40 KC. Computers, on the other hand, prefer to periodically receive large blocks of data at high speed (hundreds of KC, typically). Thus, some form of *line scanning* and multiplexing unit is used to assemble and batch input data. It communicates at low speeds with many communications circuits, and transfers data in short bursts over one high-speed channel to the computing system. Output, of course, is the inverse.

A suitable electrical and timing interface must be provided for *line compatibility* between the communications circuits and the data-processing equipment. This usually also includes the buffering of a bit, character, or small group of characters on a per-line basis (to reduce the speed and amount of scanning), but usually much less than a complete message.

Organization of Switching Centers

Computer systems organized for

World Radio History

control of switching centers must satisfy four basic needs:

(1) The center must be available for operation 24 hrs a day, 365 days a year.

(2) The center must be organized in such a manner that loss of traffic is almost impossible, regardless of equipment failures.

(3) On-line changes in codes, formats, and signaling speeds must be easily done.

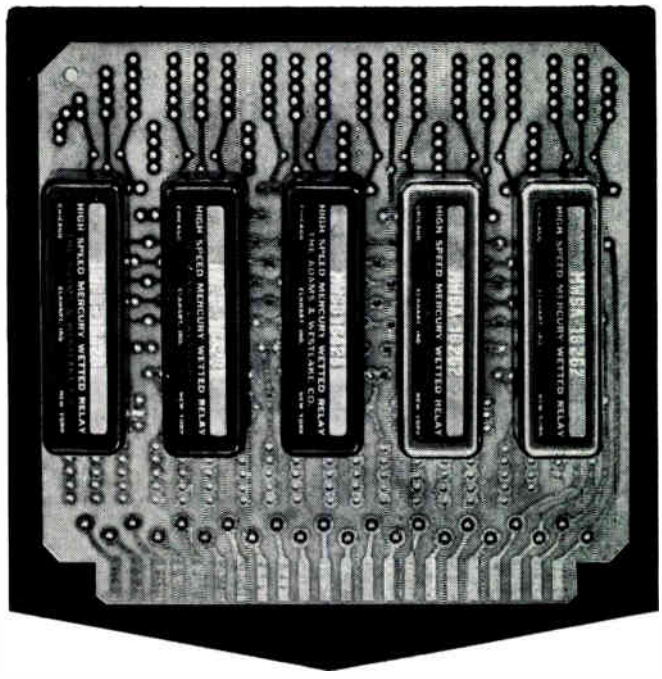
(4) There must be a large growth capacity for additional channels and increased traffic volume. And, the organization must be such that expansions do not disrupt system operation.

Biggest single obstacle to computer implementation of switching centers is the need for around-the-clock availability. A single computer at the heart of a switching center (Fig. 2) has the drawback of terminating all service whenever any one of its components malfunctions.

To overcome this difficulty, a duplex computer approach is taken, Fig. 3. This approach doubles computer system cost and introduces a new vulnerable element—switchover equipment. Duplex computers can operate in three modes: (1) Load-sharing, with reduced capability whenever only one is available; (2) parallel operation with comparison of outputs; or (3) one active and one standby. Disadvantages of the three modes are that: (1) The computer complement is either grossly inefficient (duplex) or heavily overloaded (one completely down); (2) the problem of finding which computer failed whenever the two do not agree is almost as severe as the switchover from failed computer to operable computer; and (3) a single failure in one computer while the other is down for maintenance produces the same catastrophic system failure as it would in a single-computer system.

A recent development in computer setups for high-availability uses such as switching centers is the modular data processing system, Fig. 4. This system cannot be totally disabled by a single failure of a system element, and operates, in effect, with active spares. Total redundancy is accomplished simply by including one more module of each type than is functionally needed. For example, where a system needs three memory modules, four are supplied; as long as any three are available, the system is operational, and with only two remains at least partially operational. Even the switching matrix can be physically distributed among system modules, to ensure isolation of any switching failure to the associated module. Total downtime of a fraction of an hour in a year of operation can be reasonably predicted because of the modular organization.

The system is not controlled by computers. It is controlled by an automatic operating and scheduling program permanently contained in fully shared memory, and run by each computer module as needed, to determine assignments. The program (Fig. 5) thus enables a modular data processing system to schedule



NEW 200 OPERATIONS PER SECOND

These contact form C relays follow signals up to 200 operations per second without variation in timing. Are available in single-side-stable, bi-stable and chopper forms. Adlake MWSB 16000 relays like the three on the left are the only ones you'll find anywhere molded in epoxy. Though less expensive, they operate cooler. Contain no wax to overheat and run. Parts are rigidly secured —no movement to cause circuit noise. Epoxy is proof against all caustics and solvents except acetic acid. Metal encased versions on the right can be grounded to assure magnetic shielding. Use them where magnetic interference is a special problem. Get all the facts.

Send for a free catalog.

Type 1040 Mercury Displacement

Type 1101 Mercury Displacement

Type MW-1600 Mercury Wetted

Type MWB-1600 Mercury Wetted

Adlake makes more kinds of mercury relays than anybody

Visit Booth 1618 at the ISA Show

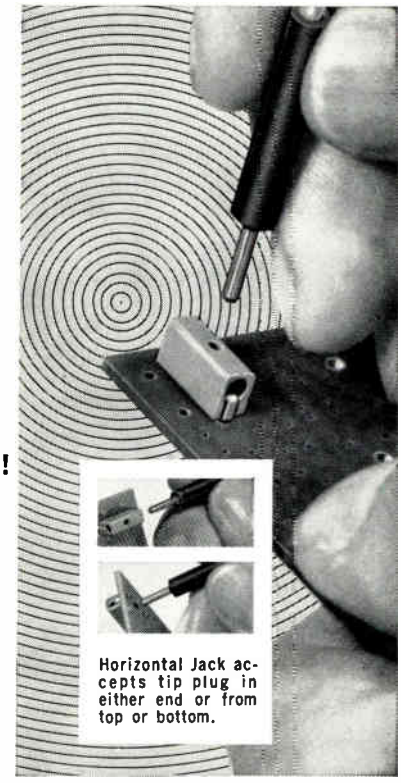
A+ Adlake® RELAYS

The Adams & Westlake Company, Dept. P-4609, Elkhart, Ind.
Phone Area 219, COngress 4-1141

World Radio History

Designed for printed circuit use!

MINIATURE PLUGS AND JACKS



Operating voltages to 1500 V RMS... up to 5 amps current carrying capacity!

Extremely compact — highly resistant to extremes of shock, vibration, temperature and moisture, these tiny Johnson Tip Plugs and Jacks are ideal for limited space applications! Bodies molded of tough, low-loss plastic per MIL-P-17091. Available in 10 colors, including basic colors for MS16108C coding applications. Contact resistance: less than 2 milliohms. Capacitance between two adjacent jacks: less than 1 mmf. at 1 Mc.

Series 105-751 Horizontal Jack — Unique design accepts .080" diameter tip plug in either end, or from top or bottom. Formed silver-plated beryllium copper contact. 2 terminals.

Series 105-851 Vertical Jack — Mounts through single .052" hole, requires minimum mounting area. Silver-plated, machined beryllium copper contact.

Series 105-771 Sub-Miniature Tip Plug — For use with miniature jack. .080" diameter tip. Nickel-plated, machined brass body. Solder type lead connection.

Series 105-881 Long Handle Tip Plug — Identical to tip plug above, but with 4" molded plastic body for ready access to "hard to reach" test points.

Components Catalog Available—Write today on company letterhead!

E. F. JOHNSON CO.
3007 TENTH AVE. S.W. • WASECA, MINN.
®

CAPACITORS • TUBE SOCKETS • CONNECTORS
PILOT LIGHTS • INSULATORS • KNOBS AND DIALS • INDUCTORS • HARDWARE

Other Connectors — Johnson also manufactures standard connectors including Tip Plugs and Jacks; Metal-Clad and Rapid-Mount Jacks; Banana Plugs and Jacks; Binding Post. Voltage breakdowns to 12,500 volts DC. Jacks designed for fast, easy mounting — plugs for solderless connection. Current catalog provides full specifications on complete line.

itself, adapt to changes and growth in its workload (without reprogramming), and diagnose and automatically bypass its own failures. Individual program routines, and their relative sequencing and priorities, can be changed, deleted, or added without disturbing the entire programming system.

Example of a Switching Center

Implementation of a switching center with a modular processor can best be shown by example. The first such implementation is the Automatic Message Processing System being developed by Burroughs Corp., for the U. S. Army.

System Functions.

Prime function of this system is accepting, storing, and transmitting message traffic, Fig. 6. Within this framework, the system is capable of:

(1) Processing digital data in any standard military code and format, and at all currently used or contemplated signaling speeds.

(2) Complete compatibility with existing manual, semiautomatic, and automatic terminals.

(3) Efficient handling of multiaddress messages.

(4) Maximum efficiency in use of communications circuits.

(5) Automatic message retrieval.

(6) Accumulation of statistical information.

(7) Storage of canned messages.

(8) Automatic message display at electronic consoles, to permit manual designation of local distribution.

Human intervention is needed only where procedures dictate, or under abnormal conditions. Checks are routinely made of precedence, security, format, code, distribution, routing, equipment status, and so forth, and a comprehensive alarm system is provided.

Basis of the System: the D825.

The Automatic Message Processing System is based on the Burroughs D825 Modular Data Processing System.[3,4] For this use, the D825 is arranged (Fig. 7) to include 2 computer modules, 6 memory modules, 4 I/O control modules, 15 I/O devices, 2 data demand modules, and 3 data buffer modules, each of the latter serving up to 72 full-duplex communications channels. (The data demand and data buffer modules perform the line scanning and buffering functions referred to previously.)

The system provides for automatic control of intermodule communications, automatic assignment of work from a common job file, direct access to memory modules by all computer and I/O control modules, multiple parallel operations, and real-time response to a variety of internal and external interrupts, without damage to interrupted programs. It

World Radio History

operates under control of an executive program—the Automatic Operating and Scheduling Program[5].

System Organization.

The Automatic Message Processing System is organized as three intercommunicating matrices. The three crossbar-type exchanges, interconnecting various modules of the system, do not exist as separate pieces of hardware. They are distributed among the modules they serve. Thus, the failure of any one module cannot affect others connected to the same exchange.

The message processing subsystem central exchange provides interactions between magnetic-core main memory modules and the computer modules, data demand modules, and I/O control modules. It automatically resolves simultaneous attempts at access to a single module.

The I/O exchange provides several independent, simultaneous, data paths between I/O control modules, bulk storage, and message displays.

The data demand exchange connects data-demand modules to subscribers through the data buffer modules.

Data-demand and I/O control modules service their respective exchanges with data and formats consistent with proper operation of the various devices, but use high-speed word transfers for communication with memory modules.

All modules, including those provided for backup, are on line, permitting the performance of confidence checks on all equipment, and status display of equipments and communications channels for maintenance and supervisory personnel. When confidence checks indicate a malfunction, diagnostic routines automatically delete the failed module from the operating system complement, and repair of failed modules is done off-line without disturbing system operation. The system is protected against loss of irretrievable information by redundant storage of such information.

Equipment Characteristics.

The computer modules operate synchronously at 3 MC, and include magnetic thin-film registers for nonvolatile storage of 128 words in each module. One function of these registers is to maintain an "image" of the current status of the job in progress, so that, in the event of an interrupt, the image can be transferred to memory to be later reassigned and resumed from the point of interruption.

Each memory module (two per standard cabinet) includes a random-access, linear-select, ferrite-core memory of 4096 words (49 bits each), and associated read, write, address, sense, and control circuits. The memory has a read/write cycle (repetition rate) of 4 μsec.

The I/O control module—actually a small data processor that permits multiple parallel processing—controls the transfer and formation of data between core memory and peripheral devices (magnetic disc and drum files, magnetic tapes, line printer, supervisory console, and message display consoles). The I/O control modules (two per standard cabinet) control all terminal devices, accept instructions from both computer modules, generate interrupts recognizable by the computers, and operate simultaneously. Each I/O exchange has a transfer capability of 250,000 49-bit words (two million alphanumeric characters) / sec.

The data demand module controls the exchange of data, through data buffer modules, between memory modules and up to 512 communications channels. A data word and a descriptor word are maintained for each channel; the descriptor word tells the status of the channel, the type of channel, where in main memory to store a filled data word if the channel is an input channel, and where to fetch the data word if the channel is an output channel.

Depending upon the application, as many as 72 full duplex lines can be served by one data buffer module. The module accommodates any mix of needed signaling speeds and formats, and contains all of the input sampling features found in normal communications equipment.

Processing of Typical Message

An incoming message to the Automatic Message Processing System is accepted by a data buffer module in bit-serial form (as for teletype) or in parallel form (as from input typewriters). The message is then transmitted to a data demand module in bit-serial format at ⅓ μsec./bit. The incoming data is stored until a full memory word (48 bits) is assembled and is then transmitted to a previously designated memory module. Under computer control, blocks of data are transferred periodically from memory to drum storage via an I/O control module. When a complete message is assembled on the drum, a copy of the message is stored in a magnetic-tape unit. This becomes the retrieval and backup copy. The latter is used if the primary message on the drum is inaccessible. When this transfer to tape is completed, the system acknowledges receipt of the message, and processing begins.

Message processing includes decoding and encoding, performance of various checks and routing. It also includes queuing for display on electronic consoles where such changes as may be found necessary are specified, and queuing for output.

Messages scheduled to be transmitted on a particular output channel are automatically listed in a channel queue table. As that channel becomes available, the next message in its queue table is fetched by a computer module from the drum. The computer performs needed format and code conversions, places the message in memory, and transmits the memory address to a data demand module. The message is then sent to a data buffer module for transmission on the designated output channel.

(Continued on following page)

World Radio History

Why
MAPICO
iron oxides
for ferrites, above all others?

Because...
Mapico pure synthetic iron oxides are unmatched for uniformity . . . they are subjected to the most precise production controls.

Because...
There's range . . . a Mapico iron oxide raw material is available for every end use area from deflection yokes to temperature compensated cores to hard ferrites.

Because...
Mapico iron oxides are made in three typically different particle shapes . . . each available in several ranges of particle size.

Because...
Selection of the right Mapico iron oxide gives controlled electronic characteristics and shrinkage.

MAPICO
offers a useful, up-to-date chart on these many oxides with detailed data on particle shapes and other properties.

WRITE FOR IT TODAY!

MAPICO IRON OXIDES UNIT
COLUMBIAN CARBON COMPANY
380 Madison Avenue, New York 17, N. Y.
BRANCH OFFICES IN PRINCIPAL CITIES

COLUMBIAN CARBON COMPANY
380 Madison Avenue, New York 17, N.Y.
Please send me the new, up-to-date chart on MAPICO IRON OXIDES FOR FERRITES.
Name.....
Position.....
Firm.....
Address.....
City.....Zone.....State.....

MESSAGE SWITCHING (Concluded)

Typical delay through the system—from the time the first bit of an incoming message enters a data buffer module until that bit leaves the switching center—is on the order of a few seconds.

The Future

In terms of numbers, the use of computers in message switching centers has barely begun. Their use will increase as new switching centers are needed and as old torn-tape or electromechanical centers are replaced.

The old torn-tape relay had a big advantage over centralized systems: it was very modular, and equipment failures affected only a single communications circuit.[6] Communicators are well aware of this advantage, and can be expected to enthusiastically endorse a return to modularity. Recent specs for contemplated installations have demonstrated this awareness of the advantages of modular systems.

Economic advantages of message switching networks over circuit switching systems hinge on the relative costs of communications circuits and switching equipment. While the cost of communications circuits (especially wideband facilities) is steadily decreasing—favoring circuit switching—the cost of message switching equipment can be expected to follow suit. This is particularly true of modular systems which can be simply tailored and retailored to the varied needs and growth of individual switching centers. Thus, relative futures of message and circuit switching are not likely to be decided by economic factors, but by the varied services and conveniences each offers. It would seem that the next logical step is the combination of circuit and message switching in the same network, thus offering the subscriber the advantages of both.

Acknowledgement

The author wishes to acknowledge extensive contributions to the preparation of this article by William W. Carver, Supervisor, Publications, Paoli Research Laboratory, Burroughs Defense and Space Group.

References

1. Wolff, Fred G., "Application of a Modular Data Processor to Store-and-Forward Message Switching Systems," *Proceedings, Ninth National Communication Symposium*, Oct., 1963.

2. Picus, Fred., and Donecker, Robert R., "The Automatic Message Processing System: A Secure Store-and-Forward Message Switching Center," *Digest of Technical Papers, Sixth International Symposium on Global Communications*, June, 1964.

3. Anderson, James P., Hoffman, Samuel A., Shifman, Joseph, and Williams, Robert J., "The D825—A Multicomputer System for Command and Control," *AFIPS Proceedings, 1962 Fall Joint Computer Conference*, Dec., 1962.

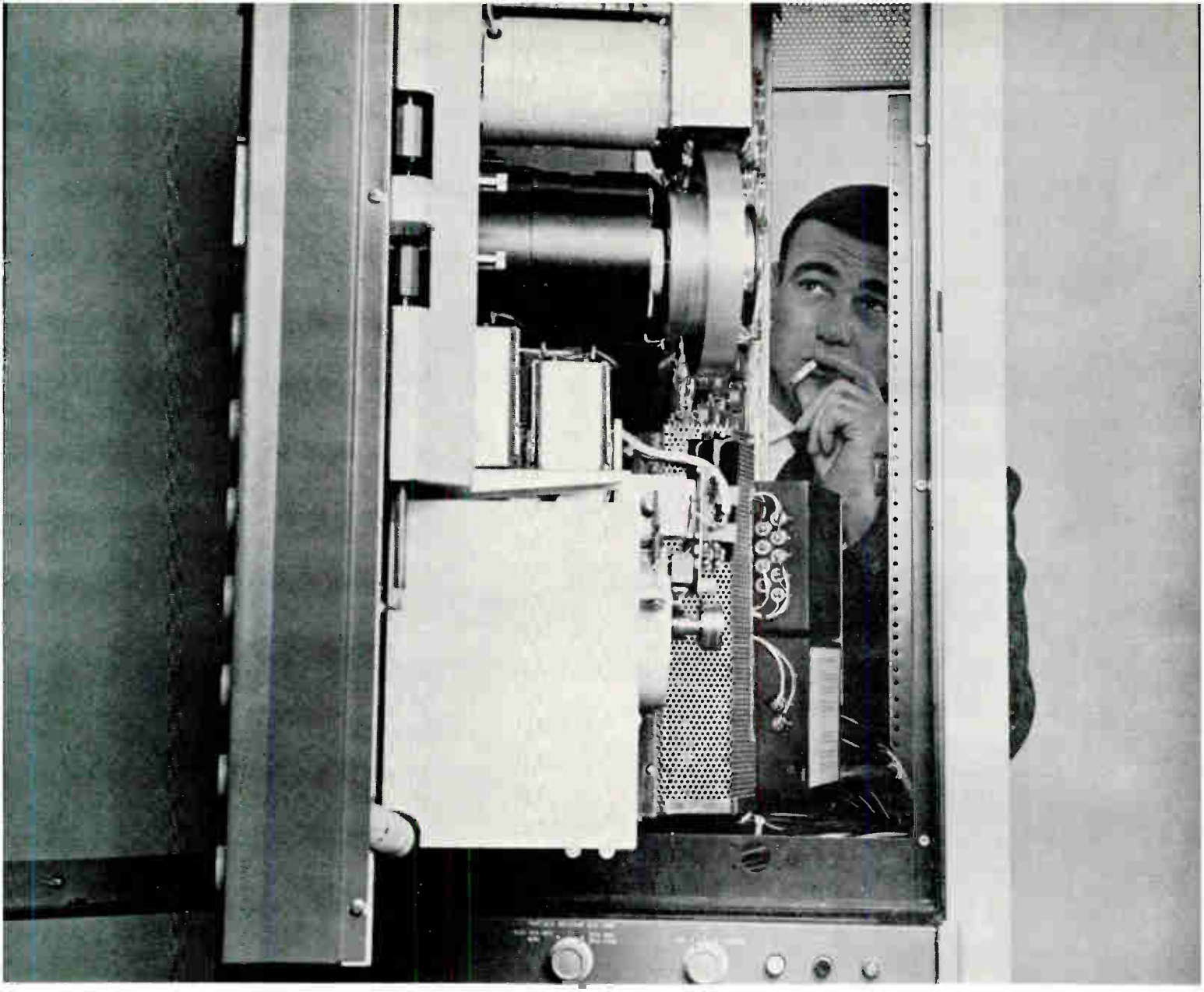
4. Anderson, James P., "The Burroughs D825," *Datamation*, pp. 30-34, April, 1964.

5. Thompson, Rankin N., and Wilkinson, John T., "The D825 Automatic Operating and Scheduling Program," AFIPS Proceedings, *1963 Spring Joint Computer Conference*, May, 1963.

6. Wolff, Fred G., "New Trends in Communications Switching," presented at Air Defense Command Data Automation Symposium, and published in *Signal*, pp. 40-41, March, 1964.

• A REPRINT of ANY ARTICLE in this issue is available from ELECTRONIC INDUSTRIES Reader Service Department.

World Radio History



Wonder what you've been missing in data recording?

You'll find it with CEC's VR-2600

This instrument is universally acclaimed as the finest, most versatile performer in its class. And for many significant reasons. The VR-2600 is a completely integrated, multi-channel, wide-band data recording and reproducing system embodying unique concepts of accuracy, reliability and simplicity. Consider these specifications . . .

- All solid-state electronics for high reliability and low power consumption —with color-coded, back-lighted, push-button controls.
- Six speeds in two ranges (1⅞-60 ips; 3¾-120 ips) electrically selectable, with no adjustments required.
- Complete 7- or 14-channel record and playback system housed in single or dual cabinet (optional), with plug-in conditioning amplifiers available to handle Direct, FM, PDM, and PCM techniques.
- Handles data in the 400 cps—600 kc range via direct techniques; in the d-c—80 kc with FM techniques; IRIG PDM via PDM electronics; 1000 bit/inch each of 16 parallel tracks for saturation PCM recording/reproducing.
- Closed-loop tape tension control maintains a constant, non-variable tension in the tape, regardless of the operating mode.

All this adds up to the fact that the versatility of the VR-2600 makes it ideal for a wide variety of uses, including environmental testing, structural or transient studies, radar recording or telemetry. And it performs with perfection in laboratory, mobile, shipboard, trailer or blockhouse operations. Is it any wonder that this instrument is consistently recommended for both industrial and military service?

For full information about the VR-2600, call or write for Bulletin CEC 2600-X11.

CEC

Data Recorders Division

CONSOLIDATED ELECTRODYNAMICS

A SUBSIDIARY OF **BELL & HOWELL**/PASADENA, CALIF. 91109
INTERNATIONAL SUBSIDIARIES: WOKING, SURREY, ENGLAND AND FRANKFURT/MAIN, GERMANY

World Radio History

ELECTRONIC INDUSTRIES

NEW TECH DATA

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

Transistor Catalog

Short-form catalog CN-116F gives salient characteristics of 163 different silicon and germanium transistors. Included are silicon-epitaxial planar types, ECDC germanium types, and MADT, MAT, and SBT germanium designs. Technical Literature Section, Sprague Electric Co., Marshall St., No. Adams, Mass.

Circle 120 on Inquiry Card

Microcircuit Bulletins

Bulletin HD-1 describes types HD903-905 NOR/NAND gates. Characteristics: network dissipation, 80mw; rise time, 120 nsec.; propagation delay, 35nsec. Bulletin HD-2 describes a 3-stage audio amplifier which has a power gain of 54.5db and dissipates 35mw. International Resistance Co., 401 N. Broad St., Phila., Pa.

Circle 121 on Inquiry Card

General-Purpose Transistors

Data is available on 2 general-purpose high-voltage PNP silicon transistors suitable for both switching and small-signal audio uses. Types 2N3250 and 3251 have a rise time of 175nsec. and a fall of 50nsec. Noise figure is 6db max. @ 100 cps, small-signal current gain is 50 and 100 min. for types 3250 and 3251 respectively. Motorola Semiconductor Products Inc., P. O. Box 955, Phoenix, Ariz.

Circle 122 on Inquiry Card

Capacitor Catalog

This short-form catalog describes a line of metallized polycarbonate capacitors. Rated at 0.001 to 10μfd in 200, 400, and 600vdc ranges, they operate from —55° to 125°C. Marshall Industries, 1960 Walker Ave., Monrovia, Calif.

Circle 123 on Inquiry Card

Comparing Capacitors

This technical bulletin gives designers a handy way of comparing electrical performance of glass capacitors with ceramic, mica, paper, paper plastic, paste electrolyte tantalum and solid electrolyte tantalum capacitors. Seven test procedures are covered, with capacitance changes listed for each type. Electronic Products Div. of Corning Glass Works, Raleigh, N. C.

Circle 124 on Inquiry Card

Silicon Transistors

Data sheets describing the 2N2102-2102A silicon Leaf® planar epitaxial NPN transistors are available. These units are designed for amplifiers and high-speed switching, and have low saturation voltage, high gain, and good Beta linearity. The sheets contain operating characteristics and curves. Bendix Corp., Semiconductor Div., Holmdel, N. J.

Circle 125 on Inquiry Card

Tubes

Electron tubes for general-purpose uses, pulse modulation, high-voltage switching, high-voltage rectification, and TV camera use are described in this 28-page catalog. Included are 78 triodes and tetrodes, 16 pulse modulators, 8 high-vacuum-high voltage rectifier diodes, and 8 vidicon tubes. The Machlett Laboratories, Inc., Springdale, Conn.

Circle 126 on Inquiry Card

Design Engineering File

This file provides a ready reference to a complete line of semiconductors including types, specs. and characteristics, test circuits, uses, manufacturing methods, and prices. The file contains handbooks for each major product line. Sarkes Tarzian, Inc., Semiconductor Div., 415 N. College, Bloomington, Ind.

Circle 127 on Inquiry Card

Tape Dropouts

Dropouts — their primary causes and what is being done to combat them—are analyzed in Bulletin No. 10. Almost eliminated have been the gross tape defects, but dropouts continue to be a problem in the more critical uses. Magnetic Products Div., 3 M Co., 2501 Hudson Rd., St. Paul, Minn.

Circle 128 on Inquiry Card

Molded Plastics Catalog

"Laminated and Molded Plastics," 12 pages, contains characteristics and uses of laminated plastics. These include paper, canvas, linen, asbestos, glass and nylon fabric base material, and copper-clad laminates for PC and thin multi-layer circuits. Thiokol Chemical Corp., North Enterprise Ave., Trenton, N. J.

Circle 129 on Inquiry Card

Low-Pass Filter

Data is available on a miniaturized linear-phase low-pass filter with a pass-band of 0 to 4kc. Initially developed for the Apollo program, the L-C filter meets both Mil-F-18327 and NASA NPC-200 specs. Designated LP 500, it was designed for use in standard communication and IRIG telemetering systems. Rolloff is 40db/octave. Input and output impedance is 470Ω. Bulova Watch Co., Inc., Woodside, N. Y.

Circle 130 on Inquiry Card

Semiconductor Catalog

Catalog 640.10, 40 pages, gives uses and characteristic ratings for a complete line of more than 1400 semiconductors. Hundreds of transistors, diodes, injection lasers, light-emitting diodes, rectifiers and SCR stacks are listed. Integrated circuits and military specs. are also discussed. General Electric Co., Semiconductor Products Dept., Electronics Park, Syracuse, N. Y.

Circle 131 on Inquiry Card

Relay Catalog

This 12-page easy-reference catalog describes 200 most widely used Sigma relays available for industrial, commercial and military service. All listed relays are illustrated and dimensioned. Concise text and tabular descriptions are provided. Sigma Instruments Inc., 170 Pearl St., Braintree, Mass.

Circle 132 on Inquiry Card

Telephone Jacks Catalog

Catalog J-103, 2 colors, contains engineering drawings, spec. and operating features of telephone jacks and jack panels. It features new black phenolic jack panels (Series 1400 and 1500), jack panel accessories, and dual jack blocks (series 2300). These jack blocks are an economical means of installing a limited number of telephone jacks in panels. Switchcraft Inc., 5555 N. Elston Ave., Chicago, Ill.

Circle 133 on Inquiry Card

Metal Film Resistors

FE5 is a 1/20w. miniature resistor. The unit dissipates 0.05w. to 125°C and derates linearly to 175°C. It meets all Mil-R-10509E requirements. Complete specs. available from Mepco, Inc., Morristown, N. J.

Circle 134 on Inquiry Card

Ground Stud

This ½ in. dia. miniaturized ground stud is designed for use in confined spaces. The multi-terminal device accepts up to 8 No. 18 AWG wires, establishing a truly equipotential single-point ground termination, thus reducing the possibility of ground loops and noise pick-up. Descriptive data includes spec. sheets and outline drawings for design data. Jan Engineering, 2018 Pico Blvd., Santa Monica, Calif.

Circle 135 on Inquiry Card

Transformers Catalog

Bulletin TR-6410, 12 pages, provides basic data on the spec. and selection of pulse and broadband transformers. Fifteen illustrations provide data on such factors as coupling circuit, hysteresis loop, typical magnetization curve, and typical bandpass curves. The Gudeman Co. of Calif., Inc., 7473 Ave. 304, Visalia, Calif.

Circle 136 on Inquiry Card

Solid-State Delay Relays

The CD series solid-state relays are offered in knob-adjustable, resistor-adjustable, and fixed-time delays. All offer a timing accuracy of ±10% of nominal value and a repeatability factor within ±2%. Time delay values in segments from 0.1 to 180 sec. are standard for the knob adjustable types, and 1 to 180 for the others. Complete engineering data may be obtained by Potter & Brumfield, Princeton, Ind.

Circle 137 on Inquiry Card

Circle 40 on Inquiry Card →

World Radio History

NOW, for the First Time

COLOR

in

PLASTIC JACKET CABLES

Introduced by

LENZ!

CONSTRUCTED TO YOUR SPECIFICATIONS!

- **Offers faster, easier and permanent identification before, during and after installation**
- **Facilitates connections between electronic units**
- **Easier to locate cables**
- **Other colors than those shown also available including black, white and special color shades**

Why confine cable jacket colors to a few dull and nondescript shades?

From the standpoint of appearance, in this newly color conscious world, the introduction of these bright new LENZ Plastic Jacket Cables is justified.

In addition faster, easier circuit identification and quicker and more accurate equipment assembly is realized.

LENZ engineers will be glad to consult with you on the use of LENZ COLOR PLASTIC JACKET CABLES on your equipment.

LENZ ELECTRIC MANUFACTURING CO.

1751 No. Western Ave., Chicago, Illinois 60647

In Business Since 1904

World Radio History

Report from

BELL LABORATORIES

THE PIGGYBACK TWISTOR

Bit element of the piggyback twistor: A copper wire, 3 mils in diameter, is wrapped with a "soft" magnetic tape 4.5 mils wide by 0.3 mil thick. Piggybacked on the first winding is a "hard" magnetic tape 6.5 mils wide by 0.5 mil thick. The wrapping angle is about 45 degrees, and there are 92 wraps per inch. The outer tape has been "loosened" in the illustration to expose the inner tape.

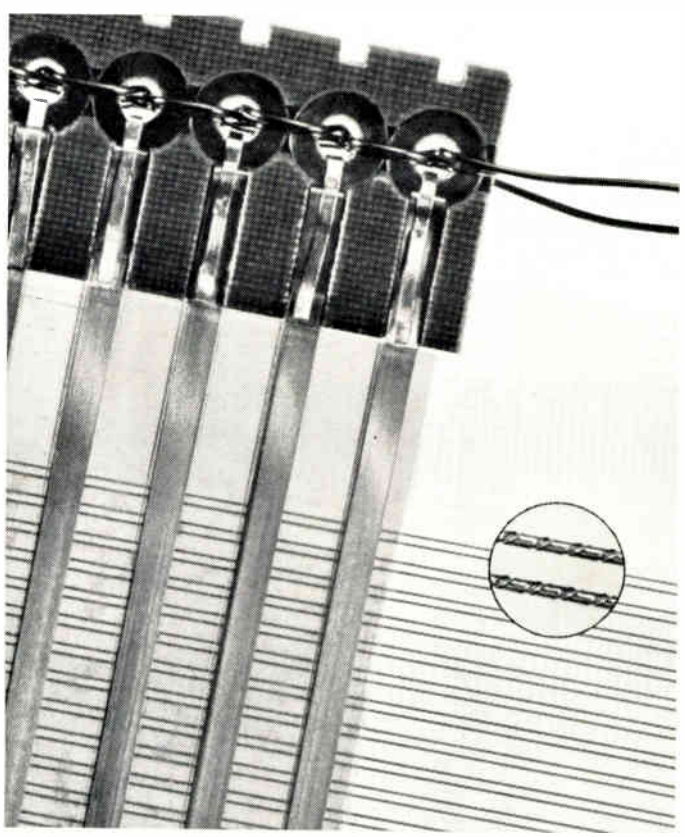
An electronic digital memory should have a fast operating time, a high storage capacity in a small volume, and a low cost. In many data processing systems, such as those used in the control of electronic telephone switching, two other memory characteristics are desirable: electrical alterability and nondestructive read-out.

To provide these characteristics, Bell Laboratories engineers have developed the "piggyback" twistor memory element. It consists of two dissimilar magnetic tapes spirally wrapped on a copper wire. A "soft" (easy to magnetize) magnetic tape is wrapped directly on the copper wire and is overlaid, or piggybacked, by a "hard" (difficult to magnetize) magnetic tape. The information content, or magnetic state, of the outer tape is determined by sensing the magnetic state of the inner tape with a current pulse. Sensing does not destroy the information content of the outer tape. Because the tapes can be made and handled in long lengths, wrapping the piggyback wire and assembling the module are relatively simple.

In earlier twistors, information is stored in permanent magnets which are precisely positioned over an array of singly wrapped twistor wires. In the new design, the function of the magnets is taken over by the outer tape, greatly simplifying the memory unit and reducing its volume.

Experimental piggyback twistor memories have been made and tested in modular sizes of a quarter million bits. A read-cycle time of 5 microseconds has been achieved for a 4096-word memory.

BELL TELEPHONE LABORATORIES. Research and Development Unit of the Bell System.



An array of piggyback twistor wires with their read-write word straps. To write, a current pulse is sent via a ferrite core through a single word strap. Simultaneously, another pulse is sent through a pair of twistor wires, setting the magnetic state of the outer tape. To read, a pulse is sent through the word strap alone. This pulse switches the direction of magnetization in the inner tape, thus inducing voltage in the twistor wires. (Assembly magnified 3X; insert, showing a pair of twistor wires, magnified 15X.)

World Radio History

NEW TECH DATA

Microwatt Transistors

The 2N3340 (npn) and 2N3341 (pnp) complementary switching transistors are specified in μw levels. These planar devices are ideal for ultra low-power gating, counting, control, data handling circuits, and systems. Total delay to rise time is typically 40nsec. at 50μa. Available in TO-46 packages. Sperry Semiconductor, Norwalk, Conn.

Circle 138 on Inquiry Card

Meter Catalog

Short-form catalog M642 illustrates and describes the various types of meters, including taut-band, switchboard, long scale, edgewise, aircraft, ruggedized, etc. Included are outline dimensional drawings to aid designers and engineers in their planning. The Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio.

Circle 139 on Inquiry Card

Accelerometer

Thirteen standard models of unbonded strain gage accelerometers are described in Bulletin AC2. The bulletin contains complete specs., an easy-to-use range selection chart, freq. response curves and tables, an accelerometer circuit schematic, application data, and outline drawings. Statham Instruments, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Circle 140 on Inquiry Card

Copper-Clad Laminate

Data sheet 7.521 describes a flame-retardant grade copper-clad glass epoxy laminate for use in PC applications. Designated G-10-900, the material meets or exceeds the requirements of Mil-P-13949C type GC, NEMA FR-4 as well as Mil-P-18177B type GEE. Spaulding Fibre Co., Inc., 310 Wheeler St., Tonawanda, N. Y.

Circle 141 on Inquiry Card

Circuitry Primer

"Crossbar Fundamentals" presents the fundamentals of low-level, h-f, multi-purpose crossbar switching systems. It contains graphic operational descriptions of the crossbar, a summary of characteristics, and signal-handling capabilities as well as a summary of crossbar switching uses. James Cunningham, Son & Co., Inc., Honeoye Falls, N. Y.

Circle 142 on Inquiry Card

Power Transformer Data

Data sheet F-9677 gives complete electrical and mechanical specs. for 8829 thru 9936 transformers. They are applicable to strain gage, dc amplifier and other low signal uses. They feature isolated primary and secondary shielding; shield effectiveness/winding is 55db min. Output voltages range from 6.3 to 150v. James Electronics, Inc., 4050 N. Rockwell St., Chicago, Ill.

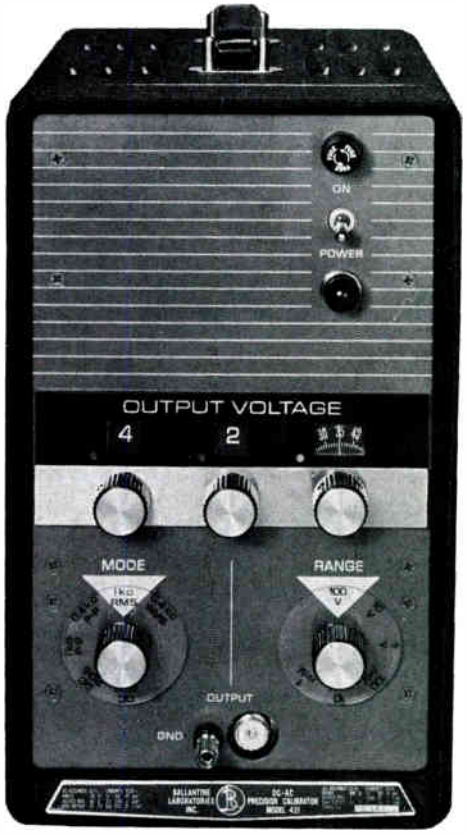
Circle 143 on Inquiry Card

PORTABLE! . . . FOR CALIBRATING VOLTMETERS, RECORDERS, OSCILLOSCOPES

(and other ac and dc voltage-sensing devices)

. . . Ballantine's New DC/AC Precision Calibrator

- Portable
- 0-111 volts ac or dc
- RMS or peak-to-peak at 400 or 1000 cps
- 0.15% accuracy
- Digital read-out
- 10% line voltage change causes less than 0.05% change in output voltage



Model 421 Price $600

Ballantine's Model 421 DC/AC Precision Calibrator has been designed for easy portability so that it may be taken *to* the instruments to be checked or calibrated, rather than to require that these instruments be brought to the calibration department. Accuracy and stability of output under conditions of widely varying power line voltage and ambient temperature are necessary requirements. The specifications show how well these requirements have been met. Versatility of output including a wide range of voltage, choice of dc or ac, choice of 400 cps or 1000 cps, and a choice of rms or peak-to-peak, multiply the applications in which Model 421 is useful. A left-to-right digital read-out of whatever voltage is selected, plus the proper location of the decimal point, simplifies its use. There are no adjustments to make other than selecting the desired mode and amplitude. 19 inch relay rack versions are available for fixed installations .

Write for brochure giving many more details

— Since 1932 —

BALLANTINE LABORATORIES INC.

Boonton, New Jersey

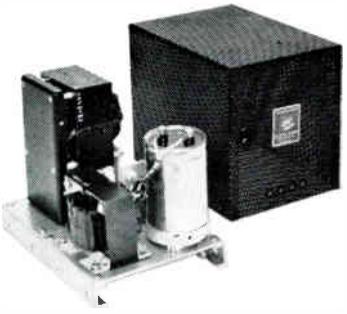
CHECK WITH BALLANTINE FIRST FOR LABORATORY VACUUM TUBE VOLTMETERS, REGARDLESS OF YOUR REQUIREMENTS FOR AMPLITUDE, FREQUENCY, OR WAVEFORM. WE HAVE A LARGE LINE, WITH ADDITIONS EACH YEAR. ALSO AC/DC LINEAR CONVERTERS, CALIBRATORS, WIDE BAND AMPLIFIERS, DIRECT-READING CAPACITANCE METERS, AND A LINE OF LABORATORY VOLTAGE STANDARDS 0 TO 1,000 MC.

World Radio History

Premium-engineered ERA Transpac® Inverters convert low voltage DC to 115 VAC, 60 or 400 cps. Solid-state designs assure high shock and vibration resistance, high conversion efficiency, stable operation and minimum maintenance. New ERA Transpac® Frequency Changers convert any 115 VAC, 50-1000 cps source to 115 VAC output, 60 or 400 cps at power levels.

TRANSPAC® INVERTERS

WRITE FOR CATALOG SUPPLEMENT #138 AND FULL DETAILS.



TRANSPAC® FREQUENCY CHANGERS

These highly stable Inverters or Frequency Changers are ideal for the exacting requirements of AC-operated equipment in lab, military or industrial applications, providing high reliability at moderate cost. *Types available:* non-regulated square-wave output; regulated square-wave output; regulated sine-wave output.

ELECTRONIC RESEARCH ASSOCIATES, INC.
Dept. E1, 67 Sand Park Rd. • Cedar Grove, N. J. 07009 • (201) CEnter 9-3000

SUBSIDIARIES: ERA Electric Co. • Advanced Acoustics Co. • ERA Dynamics Corp. • ERA Pacific, Inc.

NEW TECH DATA

PC Connector Catalog

This 44-page catalog describes PC connectors for printed-card and tape-cable uses. The Series 600 receptacle-type units are made in a variety of single and dual readouts with sizes from 6 to 210 contacts. Complete mechanical specs. and illustrations are given. Continental Connector Corp., 34-63 56th St., Woodside 77, N. Y.

Circle 144 on Inquiry Card

Delay Line

Model #73-68 delay line provides delay compensation for 9000 ft. of coaxial cable. Outstanding characteristics include: delay time is 26μsec. total; terminating resistance is 75Ω (±1%); and characteristic impedance is 75Ω (±5%). ESC Electronics Corp., 534 Bergen Blvd., Palisades Park, N. J.

Circle 145 on Inquiry Card

Alloy Control Bulletin

Illustrated bulletin SAC3585 describes the metallurgical and chemical challenges involved in fabricating, functioning, and quality control of semiconductor alloys and elements. Alpha Metals, Inc., 56 Water St., Jersey City, N. J.

Circle 146 on Inquiry Card

Inverter-Type SCRs

Fast-switching inverter-type SCRs are described in bulletin 7964. It describes the characteristics and uses of a line rated at 4.7, 16, 55, and 110a RMS. Each unit is available in forward biasing voltages from 50 to 600v. Westinghouse Semiconductor Div., Youngwood, Pa.

Circle 147 on Inquiry Card

Marketing Aid

"Know How is Our Most Important Product," describes how electronics companies can get into foreign markets and become less dependent on government work. Electronics Engineers Int'l., 57 Levant St., San Francisco, Calif.

Circle 148 on Inquiry Card

Zener Regulators

Jedec series 1N4460 through 1N4496 are 1.5w. zener regulators contained in a microminiature hermetic glass package. Voltages range from 6.2 to 200v. Max. reverse current is no greater than 0.05μa for the 15 through 200v. units. Complete specs. available from Hoffman Electronics Corp., El Monte, Calif.

Circle 149 on Inquiry Card

Digital Indicators

The 17000 series has 1-in. high characters and are readable at 60 to 70 ft. It is designed for ground and process control and can be supplied with many options, including integral driver-decoder circuits, independent feedback, and extreme environmental capabilities. Complete photos and data available from Patwin Electronics, 41 Brown St., Waterbury, Conn.

Circle 150 on Inquiry Card

World Radio History

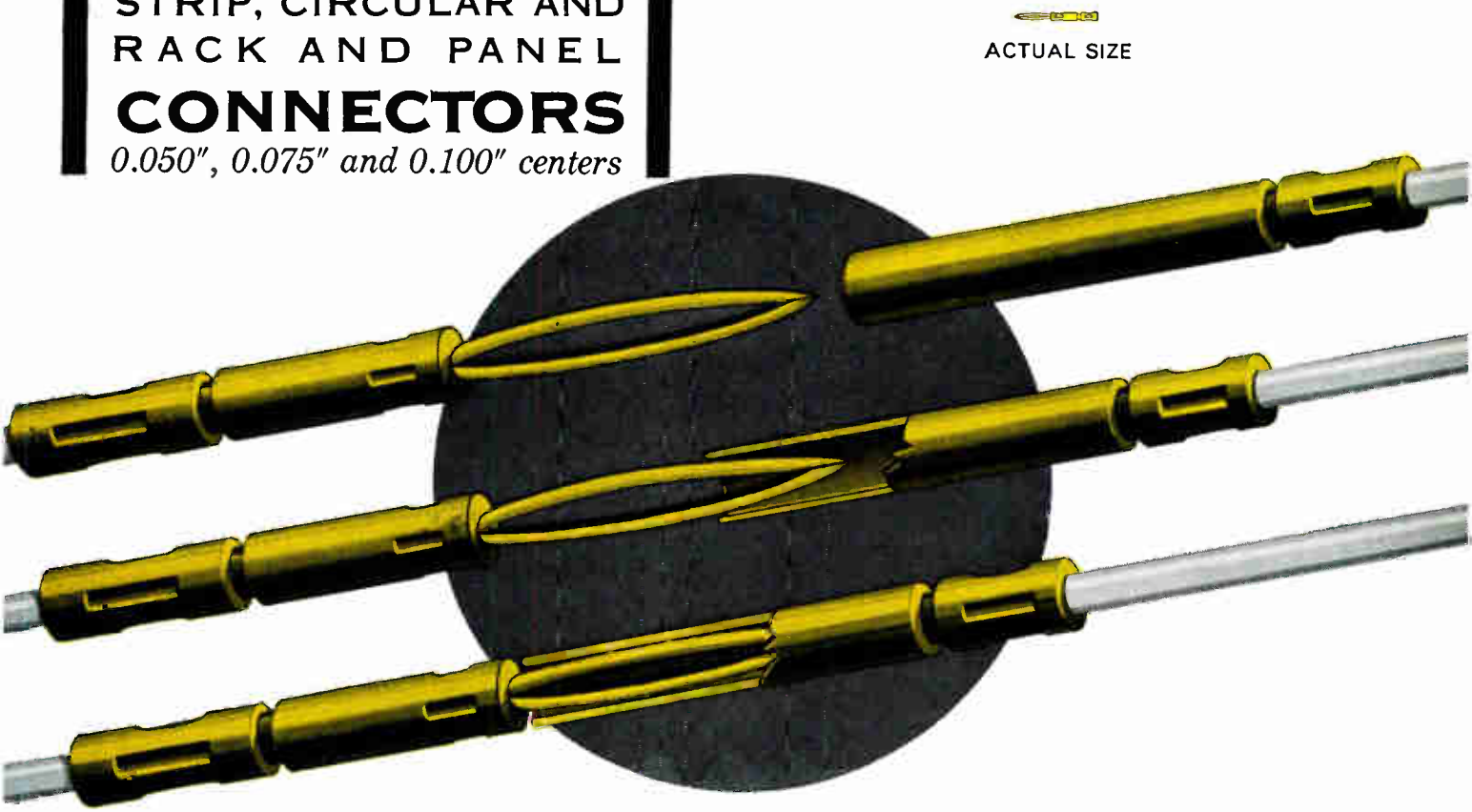
Cinch ELECTRONIC COMPONENTS

INTRODUCING A UNIQUE INTERCONNECTION CONCEPT

NEW CINCH 'BOW PIN' CONTACTS

FOR ULTRAMINIATURE, STRIP, CIRCULAR AND RACK AND PANEL CONNECTORS

0.050", 0.075" and 0.100" centers



ACTUAL SIZE

This new exclusive* Cinch concept utilizes a bowed spring principle. Two spring wires, hemispherical in cross-section, are positioned with the flat portions of the cross-section facing each other. These wires are curved slightly and fastened to the contact base so as to resemble two bows pressing against each other at the tips. The front ends of the bowed springs are not attached, permitting flexing action. This allows the wires to straighten against each other assuring a positive contact when inserted into a tube having an ID smaller than the widest dimension of the bow. *Patents Pending.

RUGGED CONSTRUCTION—The flexing members are of relatively large cross-section, to withstand abuse. NO WELDING IS USED IN THE ASSEMBLY, eliminating the possibility of heat change in spring characteristics.

ADAPTABILITY—Where many contacts are used in a connector, construction of the "Bow-Pin" can be controlled to provide a unit with a relatively low insertion force. This would result in an overall connector force that will not be excessively high. Conversely, where a few contacts are involved the construction of the "Bow-Pin" can be adjusted to provide increased insertion and retention forces.

For additional information on the "Bow-Pin" and its many advantages contact Cinch Manufacturing Company, 1026 South Homan Avenue, Chicago, Illinois 60624.

CINCH

DIVISION OF UNITED-CARR

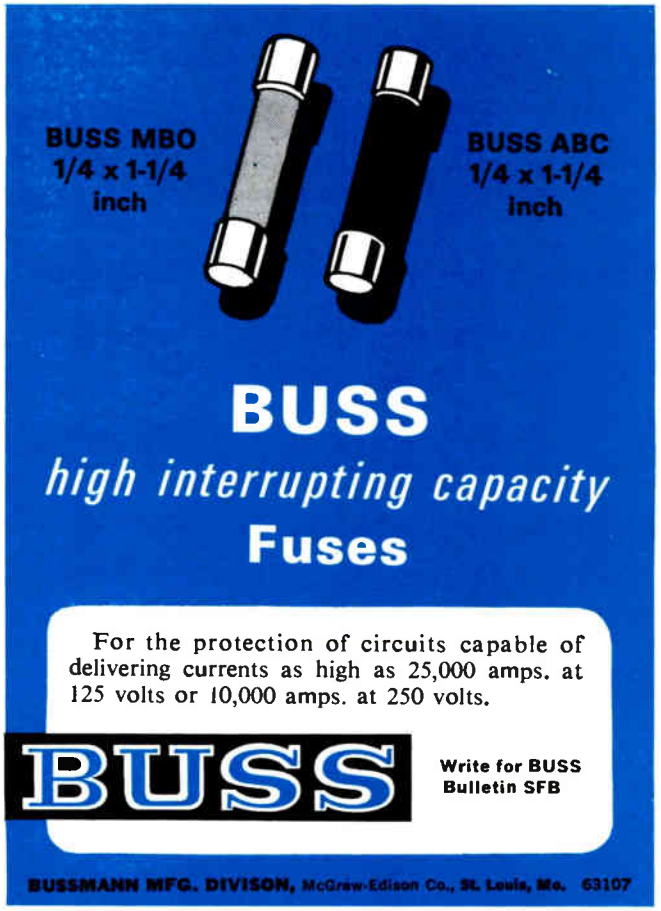
CM—6413

Circle 43 on Inquiry Card

World Radio History

Circle 44 on Inquiry Card

Circle 44 on Inquiry Card



BUSS: 1914-1964, Fifty years of Pioneering....

NEW PRODUCTS

". . . advancing the STATE-OF-THE-ART in Components & Equipment.

DIGITAL OSCILLATOR

Range is 10 CPS to 200KC; freq. response is flat within 1%.

The Vidar 820 digital oscillator with calibrated amplitude control eliminates electronic counter and RMS voltmeter for uses requiring an accurate, calibrated freq. source. It has a 4-digit freq. settability to 0.005%. Amplitude control combines a step attenuator and calibrated vernier, providing ±1% output voltages over the range of 1mv to 10v. Vidar Corp., 77 Ortega Ave., Mountain View, Calif.

Circle 151 on Inquiry Card

RF POWER METER

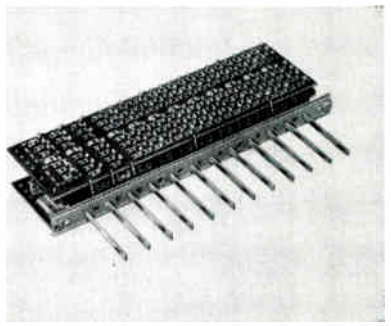
Measures average r-f power to an accuracy of ±3% full scale from 1μw to 10mw.

Model B833A uses a dc self-balancing r-f bridge for accuracies of 0.15% @ 10mw or 1.5% @ 1mw. The unit eliminates subtle errors associated with audio power in r-f bridges. Features include: a single zero adjustment; availability of thermistor heads at freqs. from 10MC to 40GC. It is lightweight and portable with optional rechargeable battery. FXR, 25-15 50th St., Woodside, N. Y.

Circle 152 on Inquiry Card

PUSHBUTTON SWITCHES

For complicated low-power switching of 125vac 6a line power.



These switches can be supplied in multiple banks—up to 18 buttons/band—or as a complete sub-assembly with lighted pushbuttons. The pushbuttons provide switching configurations up to DPDT/button/side, with up to 6 contacts/button. Double-sided switches provide up to 4 PDT, with up to 12 contacts/button. Contacts are of the shorting type. Oak Mfg. Co., Crystal Lake, Ill.

Circle 153 on Inquiry Card

World Radio History

INSTRUMENT WIRE

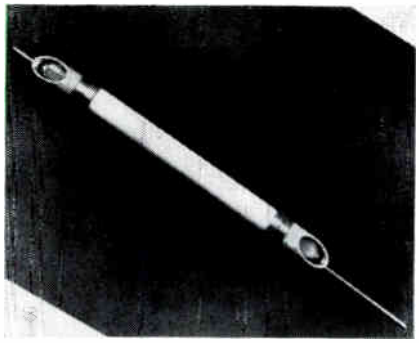
Two- and 3-conductor single-group cables for process instrumentation.

Round configuration of this wire provides better conduit fill for compact installations. They are resistant to oil and chemicals, are mechanically sound, and are designed for continuous duty in temp. from 0°F to 190°F. Rugged, standard conductors give the wire high flexibility and pulling strength. The total coverage shielded construction is recommended for critical uses such as computer and data-log inputs, where low-noise signals are needed. Dekoron Div., Samuel Moore & Co., Mantua, Ohio.

Circle 154 on Inquiry Card

LASER TUBE ASSEMBLIES

Windows mounted on the ends are elliptical and Brewster-angle mounted.

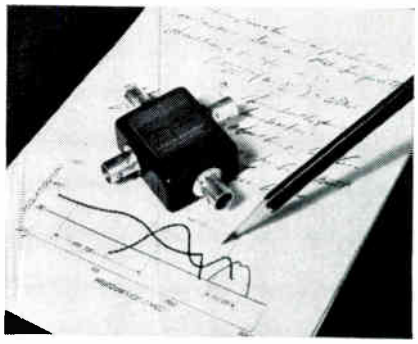


The Eimac CA8301 laser-tube assembly consists of a ceramic-metal body with 2 Eimac CA8300 sapphire window assemblies mounted at the ends. The sapphire is transparent to radiation in the infrared through ultraviolet spectrum. Advantages of sapphire in this use are its hardness, high melting point, tensile and shear strengths. The edge of the sapphire disc is metallized and plated, then high-temp. brazed to a mounting ring. Accessory Products Div., Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, Calif.

Circle 155 on Inquiry Card

HYBRID JUNCTIONS

May be used as power dividers, balanced mixers or duplexers.



Hybrid junctions can be used as power dividers to produce 2 equal amplitude, identically phased, isolated outputs. The 4-port devices can also be used as balanced mixers or duplexers to combine 2 signals and resolve them into their algebraic sum and differences while maintaining source isolation. Four models cover the 2-32MC, 20-200MC and 200-400MC ranges. They are suitable for use in broadband antennas and feeding large antenna arrays. Adams-Russell Co., Inc., 280 Bear Hill Rd., Waltham, Mass.

Circle 156 on Inquiry Card

....New Developments in Electrical Protection

Save Assembly Time with Quick-Connect Terminals on BUSS Fuseholders

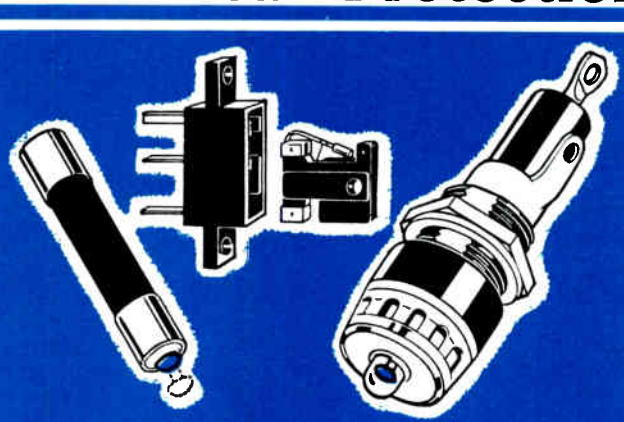
Eliminates soldering. Permits use of pre-assembled harness. Reduces assembly time.

BUSS

Write for BUSS Bulletin SFB

BUSSMANN MFG. DIVISION, McGraw-Edison Co., St. Louis, Mo. 63107

Circle 44 on Inquiry Card



INDICATING FUSES AND FUSEHOLDERS HAVE MANY USES

Unusual fuseholders and fuses perform complex functions in addition to providing safeguards for circuitry and components.

They can provide quick, positive identification of faulted circuits . . . by visual signal, by activating an alarm, or both.

BUSS

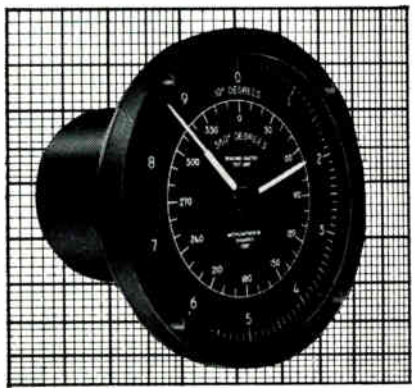
Write for BUSS Bulletin SFB

BUSSMANN MFG. DIVISION, McGraw-Edison Co., St. Louis, Mo. 63107

Circle 44 on Inquiry Card

World Radio History

For Engineers Who Need A Newer, Better



SYNCHRO MASTER TEST INDICATOR

IDC has the product! It's all new and far ahead in function and serviceability. Big, clear-view dial takes the eye-squint out of read-out. Accurate and dependable, ready for delivery.

Write for IDC Bulletin #700 for complete description.

IDC

Intercontinental Dynamics Corporation

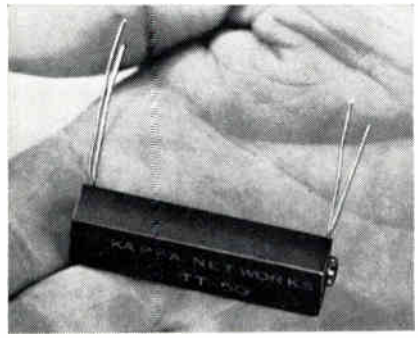
170 COOLIDGE AVENUE
ENGLEWOOD, NEW JERSEY
AREA CODE 201, LOwell 7-3600

Circle 45 on Inquiry Card

NEW PRODUCTS

VARIABLE DELAY LINES

Delay time from 0-60nsec. at impedances of 300 to 600Ω.

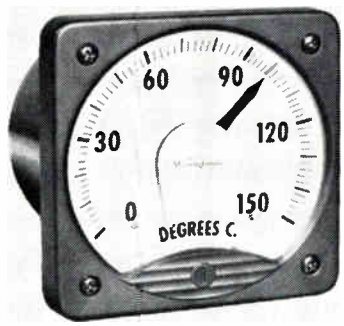


The rise time from this subminiature unit is approx. 5 to 15nsec., and dielectric strength is 30v. Resolution is better than 0.5nsec.; attenuation is below 0.5db. Kappa Networks, Inc., 165 Roosevelt Ave., Carteret, N. J.

Circle 157 on Inquiry Card

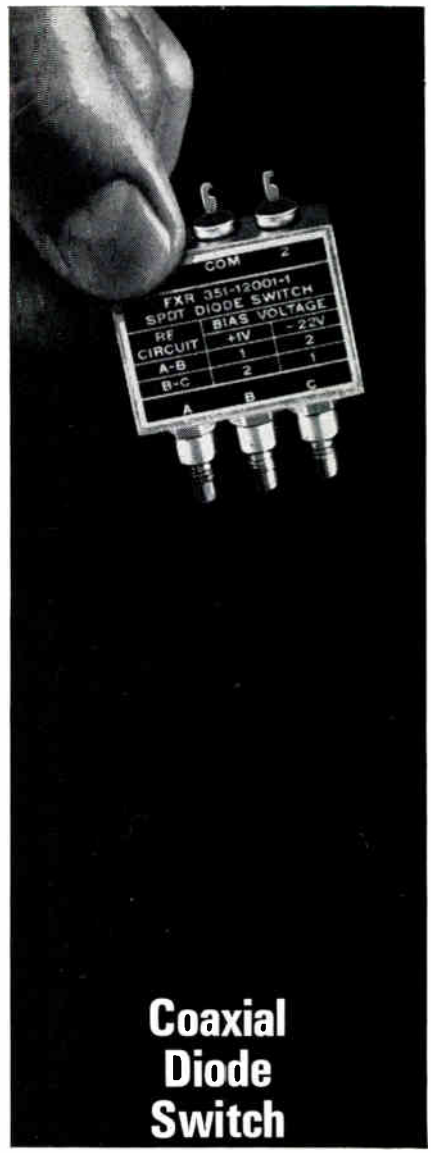
RESISTANCE THERMOMETER

For measurements in power transformers, circuit breakers, motors, etc.



Temp. measurements in heavy electrical apparatus are simple and precise with these self-contained electrical resistance thermometers. These instruments are normally supplied on switchboards, and the only external connections are to a 120v., 60-cycle source and to the exploring coils. Available scales range from a 4½ in. 90° scale to an 8¾ in. 250° scale. The unit is self-contained except for the 10Ω copper exploring coils. The instrument housing, in addition to the dc mechanism, includes a wheatstone bridge circuit, a zener-stabilized voltage regulator, and a rectifier. Only a change in resistance of the exploring coil, caused by a temp. change, will move the indicator. Normal line voltage and amb. temp. fluctuations have no effect. Westinghouse Electric Corp., P.O. Box 868, Pittsburgh, Pa.

Circle 158 on Inquiry Card



Coaxial Diode Switch

small size
small weight
small cost

This FXR SPDT model is just over an inch square and weighs one ounce. Price is small, too. Only $115. We also make a DPDT transfer model (1.5 ounces) and a SP4T model (2 ounces). All have excellent electrical and environmental characteristics through 1500 mc.

For detailed specifications on coaxial diode switches—and about 900 other coaxial switches—ask your Amphenol sales engineer for a copy of the FXR coaxial switch catalog.

Manufactured by

FXR

a division of Amphenol-Borg

Circle 46 on Inquiry Card

World Radio History

NEW PRODUCTS

R-F CALIBRATION SYSTEM

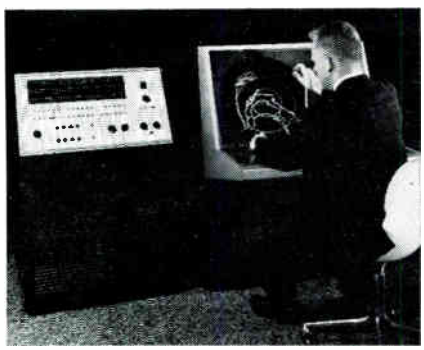
Modularized system measures currents and voltages up to 1GC.

This r-f calibration system, with accessory instruments, has ranges from 1μv to 1125v. and 0.5ma to 100a. at freqs. to 1GC. Model RFS-1 high-resolution readout system determines ac-dc differences or freq. influence. It provides readout of true RMS. Model FLH-1 ac-dc voltage-transfer standard has a range of 1.5 to 1125v. with an accuracy of ±0.01% to 30KC and ±0.02% to 50KC. Singer Metrics Div., The Singer Co., 915 Pembroke St., Bridgeport, Conn.

Circle 193 on Inquiry Card

DISPLAY CONSOLE

Simultaneously presents computer-generated and film-projected data.



The combined display of this unit is made possible through use of a special version of the Charactron® shaped-beam tube, which has an optical window built into the rear of the tube. Film frames are projected through the window onto the inner phosphor-covered surface of the tube face and are visible from the outside. The film frames are thus superimposed over the data generated by the computer. A prime advantage is the saving of valuable computer and dynamic display time through the projection of infrequently changing background data onto the display surface. General Dynamics/Electronics, P. O. Box 127, San Diego, Calif.

Circle 194 on Inquiry Card

Now, for your most exacting applications, Reeves amazing 12IG gyro — the miniature integrating gyro proven by customer testing to withstand over 500Gs with no degradation in performance. This remarkable performance, under conditions far beyond today's aerospace requirements, makes the 12IG gyro the ideal choice for the most advanced inertial reference or stabilization systems.

The 12IG measures only 1.25" in diameter, weighs but six ounces, and can be supplied with either microsyn or permanent magnet torquers. *Standard* specifications include 0.1°/hr random drift rate, and less than 1°/hr/g acceleration sensitivity. Gyros can be furnished with either beryllium or aluminum housings.

For complete technical specifications on this top reliability performer, write for data file 109.

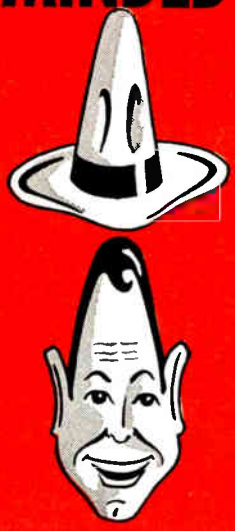
Reeves®

REEVES INSTRUMENT COMPANY
Garden City, New York
Division of Dynamics Corporation of America

DCA

World Radio History

BE NARROW-MINDED...



USE TIGHT-FITTING

SLIM-CAPS

SUB-MINIATURE CERAMIC CAPACITORS

.060" WIDE MAX. x .060" THICK MAX.

Working voltage 25 VDC. W.E.P.A. Spec. 102 nickel leads available for welding.

23 STOCK VALUES

Part No.	Capac. mmf.	Tol.	Max. Body Length
SC-1	1.0	±25%	.100"
SC-2.5	2.5	±25%	.100"
SC-5	5.0	±25%	.100"
SC-7.5	7.5	±25%	.100"
SC-10	10	±25%	.100"
SC-15	15	±25%	.100"
SC-22	22	±25%	.100"
SC-33	33	±25%	.100"
SC-47	47	±25%	.100"
SC-68	68	±25%	.100"
SC-82	82	±25%	.100"
SC-100	100	±25%	.100"
SC-150	150	±25%	.100"
SC-220	220	±25%	.200"
SC-330	330	±25%	.200"
SC-470	470	±25%	.200"
SC-680	680	±25%	.200"
SC-820	820	±25%	.200"
SC-1000	1000	±25%	.200"
SC-1500	1500	±25%	.200"
SC-2500	2500	±25%	.250"
SC-3300	3300	±25%	.250"
SC-4000	4000	±25%	.250"

Mucon makes a broad line of Subminiature Ceramic Capacitors to meet any requirement. Write for Catalog N-1.

MUCON CORPORATION

9 ST. FRANCIS ST., NEWARK, N. J. 07105

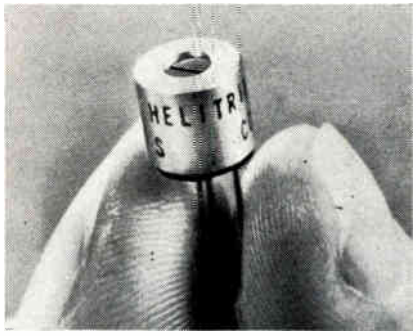
201 — MI 2-1476-7-8

Circle 48 on Inquiry Card

NEW PRODUCTS

TRIMMING POTENTIOMETER

Single-turn unit has standard resistances from 10Ω to 1 megohm.

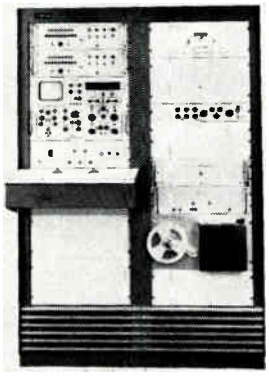


Model 61 Helitrim® triming potentiometer is a ¼ in. dia. single-turn unit with bottom pins on a 0.10 in. grid. Cermet resistance element offers essentially infinite resolution and power rating of ½w. @ 85°C. It measures 3/16 in. high and occupies less than 0.1 cu. in. of mounting space. Design features longer stainless-steel housing which completely encloses resistance element and is sealed to meet immersion tests of Mil-R-22097B. Helipot Div. of Beckman Instruments, Inc., Fullerton, Calif.

Circle 159 on Inquiry Card

TEST SYSTEM

Automated series performs dynamic testing of integrated circuitry.



The X-3000 series of systems make switching time measurements on integrated microcircuit logic modules, transistors, and related miniature circuit packages. System configurations center around the Type 567/6R1A digital readout oscilloscope, which provides both a conventional oscilloscope display of the parameter being measured and an A-D conversion of the measurement reading. Systems consist of 5 functional sections: programming, driving sources, test fixtures, waveform analyzer, and data recording. Tektronix, Inc., P. O. Box 500, Beaverton, Ore.

Circle 160 on Inquiry Card

New 1/20 watt METOHM

conformal coated metal film resistor designed to exceed MIL-R-10509E Specs.

Engineered for sub-miniature circuitry, this sturdy little resistor has a rugged end cap construction consisting of gold plated end caps and butt welded nickel leads for maximum strength and low contact resistance. And a hard, high temperature solvent resistant coating for ideal moisture protection and dielectric strength.

Here's how the entire METOHM family rates:

Metohm Type	WLC50	WLC55	WLC60	WLC65	WLC70
Rated Watts @125°C	1/20	1/10	1/8	1/4	1/2
Rated Watts @ 70°C	1/10	1/5	1/4	1/2	1
Resistance (Ohms) Min.	30.1	20	20	20	20
Resistance (Ohms) Max.	100K	301K	500K	1.3Meg.	1.5Meg.
Dimensions Max. L	.180	.280	.330	.540	.630
Dimensions Max. D	.065	.098	.100	.160	.175

Ward Leonard also supplies Vitrohm power resistors and S-coat (silicone coated) precision-power resistors. All Ward Leonard resistors are available at your local **A-I-D**istributor. Ward Leonard Electric Co., Metal Film Division, 34 South Street, Mount Vernon, New York. 4-11

WARD LEONARD METAL FILM DIVISION

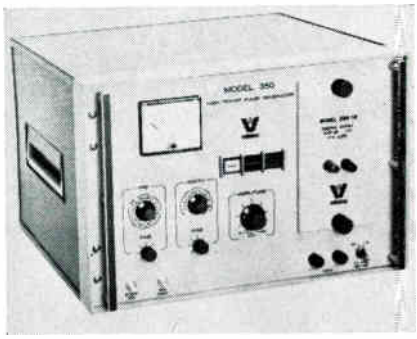
Circle 49 on Inquiry Card

World Radio History

NEW PRODUCTS

PULSE GENERATOR

Infinitely variable output to 20kw. Pulse repetition rate is 3CPS to 100KC.

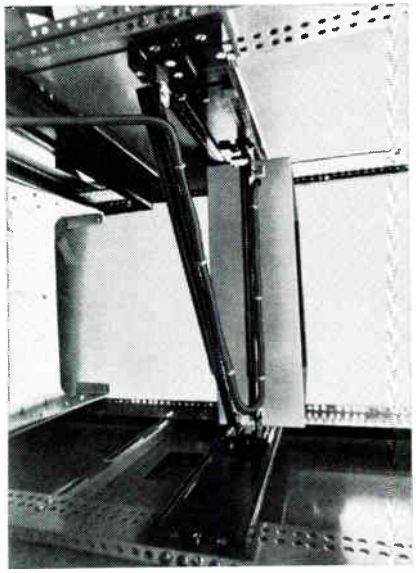


Model 350 has a pulse width which is continuously variable from 100nsec. to 200μsec. Rise time is 50nsec. and fall time is 70nsec. Output amplitude is continuously variable to 2kv into 200Ω resistive load. Velonex, 560 Robert Ave., Santa Clara, Calif.

Circle 161 on Inquiry Card

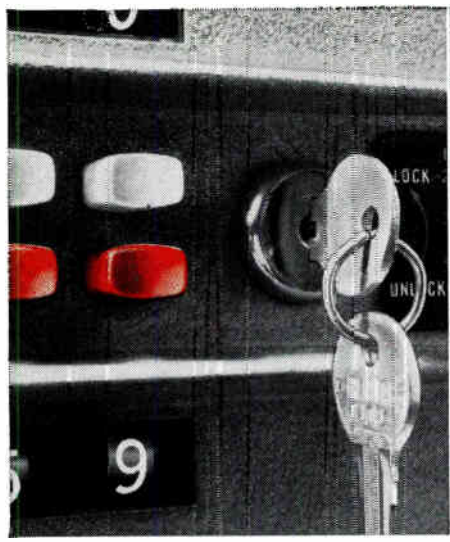
CABLE RETRACTOR

Provides workable cable control from either side of the cabinet.



The CR-2 cable retractor allows full, controlled extension and equally efficient re-insertion of the chassis. Made of corrosion resistant black anodized aluminum, the unit operates smoothly on stainless steel balls and spacers. Threaded stainless steel inserts hold cable securely, while an exclusive ¼ in. turn mechanism allows convenient quick disconnect. The cable retractor allows full use of the slide. In addition, friction-free self-lubricating nylon washers insure smooth operation at the pivot point. Grant Pulley & Hardware Corp., High St., W. Nyack, N. Y.

Circle 162 on Inquiry Card



Desired count is set by pushbuttons, with a key lock to prevent unauthorized change of the preset count.

Large, easy-to-read digit readout wheels count to 9999 . . . at up to 500 counts per minute. No reset time to delay start of next count.

The HZ760 counter is available in two models: impulse-actuated and shaft-driven. Actuates 10 ampere switches for external electrical control after a preset number of counts.

Eagle's new counter counts 3 ways . . . No reset time

Eagle's exclusive new counter is designed for fully automatic control of packaging, material handling, flow meters, cut-off devices, winding machines and similar processes. This one mechanism will serve as: 1) **a singular batch counter** that counts to a preset number, actuates a load switch and stops; 2) **a continuous batch counter** that repeats (without reset time) after counting and delivering an output pulse; 3) **an add-subtract counter** that operates one switch at zero and another at a maximum count. Count coils are rated at 50,000,000 counts. Another reliable, performance-engineered product from Eagle Signal Division, E. W. Bliss Company, 736 Federal Street, Davenport, Iowa.

BLISS EAGLE SIGNAL

Circle 50 on Inquiry Card

World Radio History

SERIES 262 MINIATURE DATA SWITCH

- Meets Crystal Can Relay Standards for Shock and Vibration
- Single Pole Unit Weighs Only .2 Ounces
- Coil Ratings: 125 to 600 mw
- Contact Rating: 4 W
- Coil Voltages: 6 to 48 VDC
- "Cradled Reed" Design

NEW CATALOG describes the complete line of Wheelock Proven Glass Reed Relays. Includes capabilities, limitations, application data, mechanical and electrical specifications.

Wheelock
273 Branchport Ave.
Long Branch, N. J.
201-222-6880

Circle 51 on Inquiry Card

NEW PRODUCTS

TRANSMITTER CRT

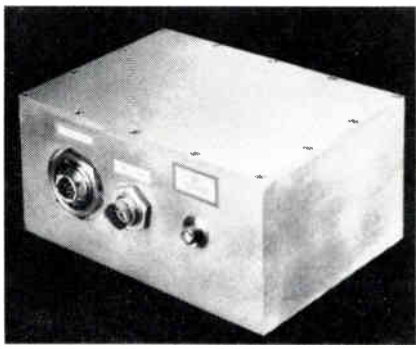
Tubes can be mounted in r-f output without demodulation.

These CRTs are for use in UHF and VHF transmitters. Non-linearity and instability associated with demodulation is avoided, and depth of modulation is determined from the r-f directly. In TV transmission these tubes can be used to directly view freq. characteristics of antennas, transmission lines, and other networks without demodulation of the r-f signal. The D13-23 for UHF is tunable to freqs. between 300 and 900 MC; the D13-16 for VHF displays r-f signals from 0 to 250MC. Both tubes are electrostatically focused and deflected, have 5 in. flat faces, and use helical post deflection acceleration systems. Amperex Electronic Corp., Tube Div., Hicksville, L. I., N. Y.

Circle 195 on Inquiry Card

TELEMETRY TRANSMITTER

Hybrid unit provides 2w r-f output in the 2.2 - 2.3GC band.



The X4527 transmitter offers h-f stability and overall efficiency of approx. 13%. Package volume is 50 cu. in. The transmitter combines an efficient solid-state power supply with an r-f power stage consisting of rugged ceramic-metal planar triode and cavity. Freq. stability is achieved by a servo system which compares the output signal with a crystal reference and applies correction to the r-f oscillator through a varactor diode. It handles FM/FM, PDM/FM, PAM, FM and PCM/FM signals. With a crystal change, the transmitter can be tuned across the entire band. Eitel-McCullough, Inc., 301 Industrial Way, San Carlos, Calif.

Circle 196 on Inquiry Card

DELAY LINES

to our packaging techniques for delay lines and filters

Thousands of standard delay lines and filters are available from ESC — yet, the increasing requirements for smaller high-density packaging often dictate custom designs — ESC engineers will work with you to develop prototypes to your exact specifications. Our latest filter fits comfortably in a match box (1" x .72" x .62") — or in your circuit.

MINIATURE FILTERS FOR SONAR

Provides 60 db minimum attenuation at 1.9 x Fc. Ripple .5 db maximum. Maximum insertion loss 1 db. Operating temp. −20°C to +85°C. Size 1" x .72" x .62".

Circle 91 on Inquiry Card

MINIATURE COMPUTER DELAY LINES

P. C. Board Mounting; delays from 10 nanosec. to 160 nanosec. or greater. 200 and 400Ω impedance with a maximum pulse attenuation of 0.5 db — pulse rise time of 3 nanosec. to 40 nanosec. max. depending upon delay.

Circle 92 on Inquiry Card

A miniature transponder line in only 6 cubic inches. Other lines for Beacons, Tacans and Vortac Systems.

Circle 93 on Inquiry Card

ESC
ELECTRONICS CORP.
534 BERGEN BOULEVARD
PALISADES PARK, N. J.
PHONE: 201-947-0400

World Radio History

NEW PRODUCTS

REED RELAYS

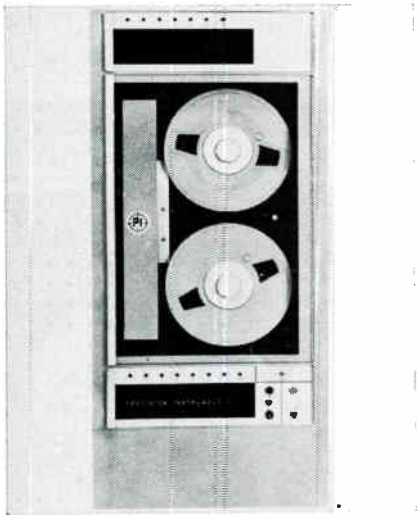
The rigid pin-type terminals literally plug into circuit boards.

The class 104 encapsulated dry-reed assemblies have preadjusted gold contacts hermetically sealed in inert gas. The spdt units operate in 1msec. and release in 1msec. Contacts are rated 3va @ 0.25a. Life is 10 million cycles. Magnecraft Electric Co., 5575 N. Lynch, Chicago, Ill.

Circle 163 on Inquiry Card

INCREMENTAL RECORDERS

Features step reading, higher speeds, convertible packing densities.



The series PI-1107 recorders are capable of both recording and reading incrementally at rates to 300 steps/sec. The unit records digital data received asynchronously as rapidly as 300 times/sec., recording data on 7 tracks on ½ in. magnetic tape in bit-packing densities of either 200 or 556/in. Both tape formats are fully compatible with most presently used data processing standards. The compact devices record random data from a wide variety of presently used equipment, including teletype, data-phones, and paper-tape system inputs. Precision Instrument Co., 3170 Porter Dr., Palo Alto, Calif.

Circle 164 on Inquiry Card

VICTOREEN DIODES
for regulation and reference
from 350 TO 30,000 VOLTS

GV1A Series, shown actual size, above, weighs 0.8 gm.

RELIABLE

Victoreen Corotron diodes enhance circuit reliability because they are free from catastrophic failure caused by nominal surges or transients . . . are immune to space radiation, even radiation greater than disaster levels. They are also unaffected by ambient light variations, have a very low TC, and withstand extremes of shock and vibration.

MICROMINIATURE

Victoreen Corotron diodes are compact, lightweight. Corotrons enable designers to use, at high voltages, the same simple circuitry used with Zeners at low voltages. A *single* Corotron diode can be used as a reference, shunt regulator, DC coupling element, or portion of a divider up to 30kV.

LOW POWER CONSUMPTION

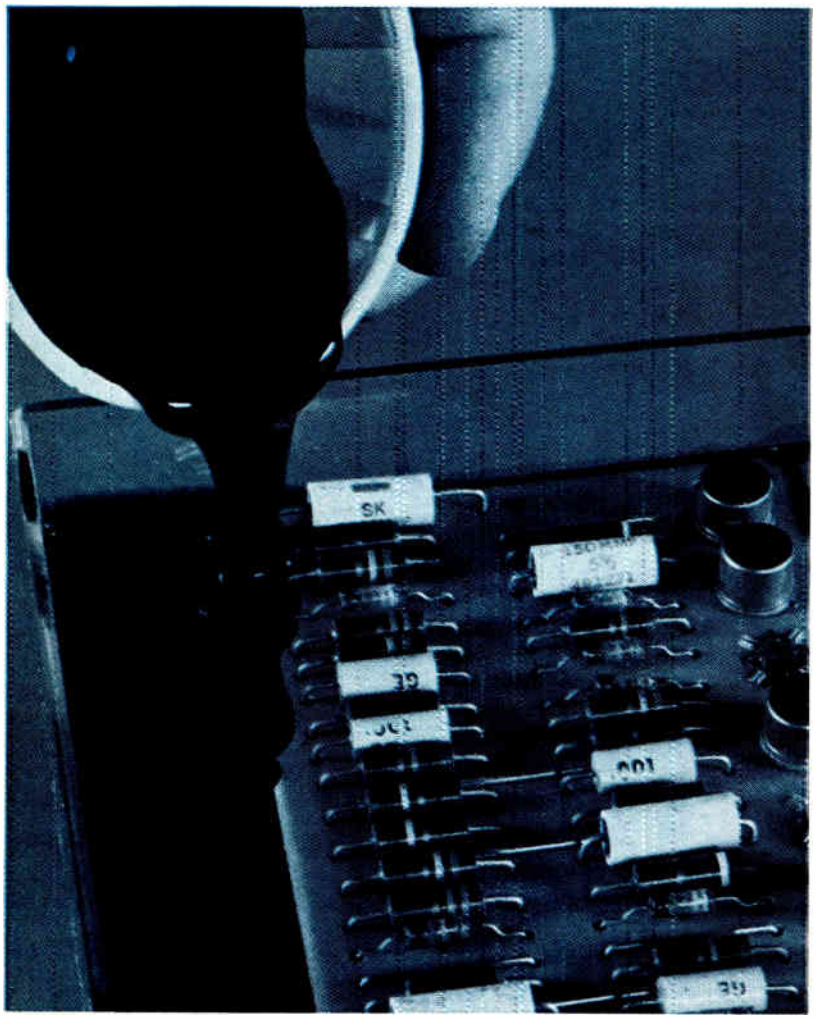
Victoreen Corotron diodes minimize power drain, can operate from solar cells and other low power sources. Excellent temperature characteristics, particularly at low currents. GVIA Series is available in any desired nominal voltage from 350 to 2000 volts; other sizes available for higher voltages and currents.

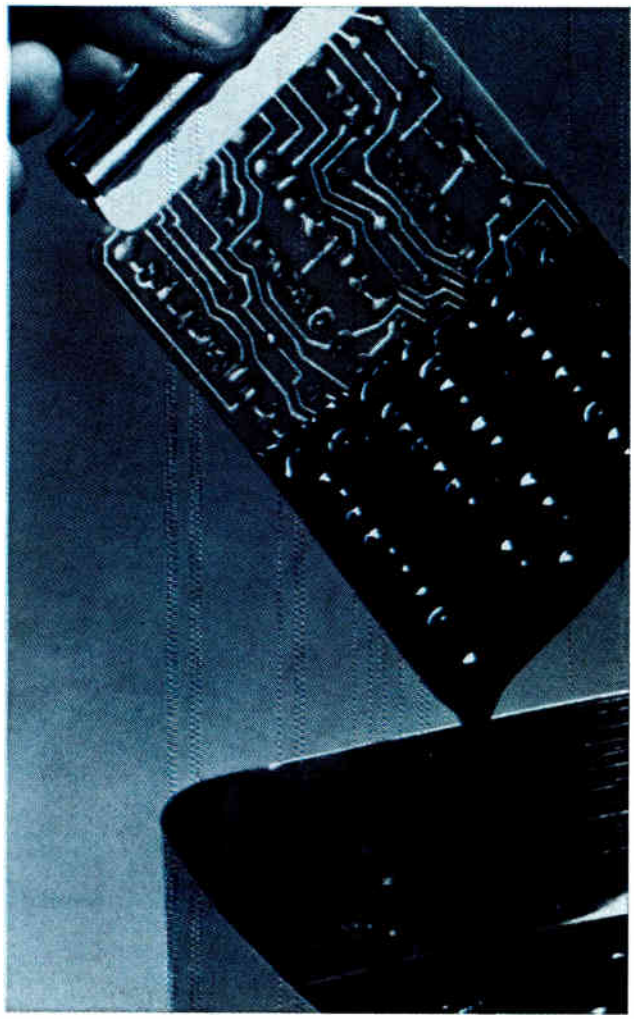
VICTOREEN

VICTOREEN
THE VICTOREEN INSTRUMENT COMPANY
5806 Hough Ave. • Cleveland 3, Ohio, U.S.A.

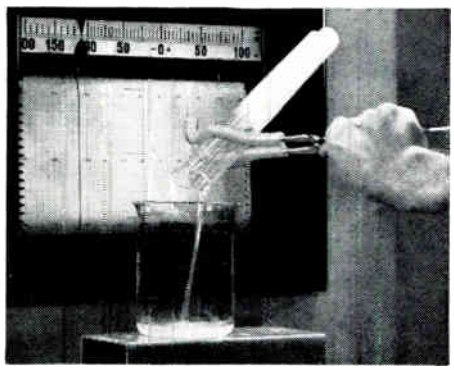
2262-A

World Radio History





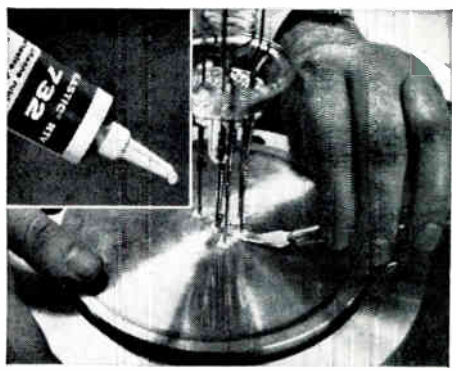
News Briefs



Airborne dielectric coolant

Dow Corning® 331 fluid is a silicone fluid especially designed to meet the exacting demands of aerospace electronic coolant applications. It is designed to meet or exceed Air Force specification MIL-S-27875, and has a wider operating temperature range than any other liquid dielectric coolant: from −90 C to 204 C (−130 F to 400 F). It flows freely when other coolants are frozen solid and provides an ideal dielectric environment in and around an electronic system.

CIRCLE 22 ON READER-SERVICE CARD



Ready-to-use silicone rubber

Used by RCA's Astro-Electronics Division to seal feed-through wires on vacuum test chambers, Silastic® 732 RTV silicone rubber adhesive/sealant remains leak-tight at vacua as high as 10^{-6} torr despite wide temperature changes and wire flexing. Outgassing is negligible, adhesion to lead wires, copper, steel and glass is excellent. Seal, bond, encapsulate with Silastic 732 RTV rubber. It cures at room temperature in 24 hours to a solid rubber; stays flexible from −85 to 500 F (−65 to 260 C).

CIRCLE 23 ON READER-SERVICE CARD

World Radio History

SILICONE NEWS from Dow Corning

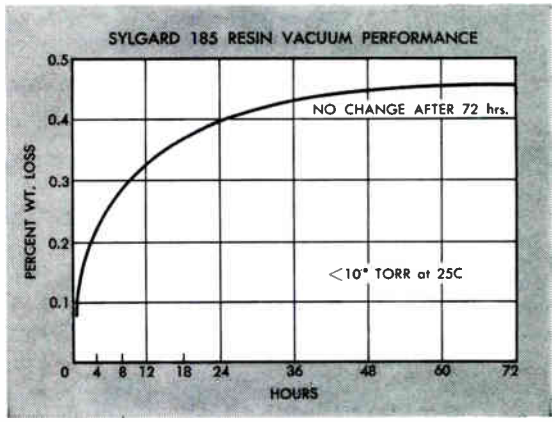
Seal out harsh environments... package with Sylgard® 185 resin

Sylgard 185 resin is an opaque, solventless silicone resin that's designed to meet the exacting requirements for an easy processing electronic packaging material that assures circuit integrity in harsh environments, including hard vacuum.

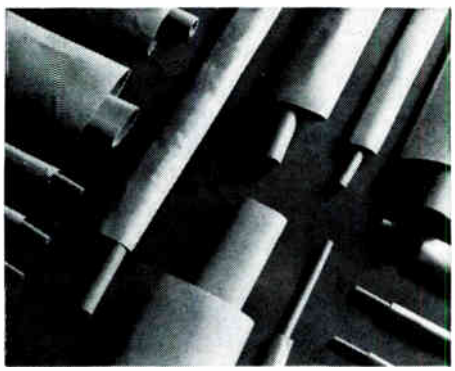
Applied as a low viscosity fluid, it flows readily around complex configurations and cures in 24 hours at room temperature without exotherm. Cured Sylgard 185 resin is tough and resilient... serviceable from −65 C to 250 C, (−85 F to 480 F)... assures reliability by providing environmental protection from radiation, mechanical shock and extreme thermal cycling.

Repair of embedded circuits or replacement of faulty components is easy. Sylgard 185 resin can be cut away with a sharp knife . . . soldering temperatures won't bother the material as repairs are made. New resin poured in place cures at room temperature to re-form the embedment.

Specify—Sylgard 185 resin where opacity is desired for security or proprietary reasons . . . Sylgard 184 resin where a transparent material is preferred. Properties are similar. The chart below indicates the low outgassing characteristic of this material in the hard vacuum of space environments. Send for your copy of Engineers' Guide to Sylgard resins.



CIRCLE 21 ON READER-SERVICE CARD



Shrinkable rubber tubing

Now, save time and labor with Silastic® 1410 heat shrinkable silicone rubber tubing. Protect cable splices, line connectors, couplings, equipment with a skin-tight rubber covering that shrinks to ½ its original diameter when heated to 300 F or higher. Lateral shrinkage is negligible. Standard tubing available from ⅛" diameter and in lengths up to 20 feet. Silastic 1410 tubing is unaffected by overheating during shrinking—will withstand temperatures to 700 F.

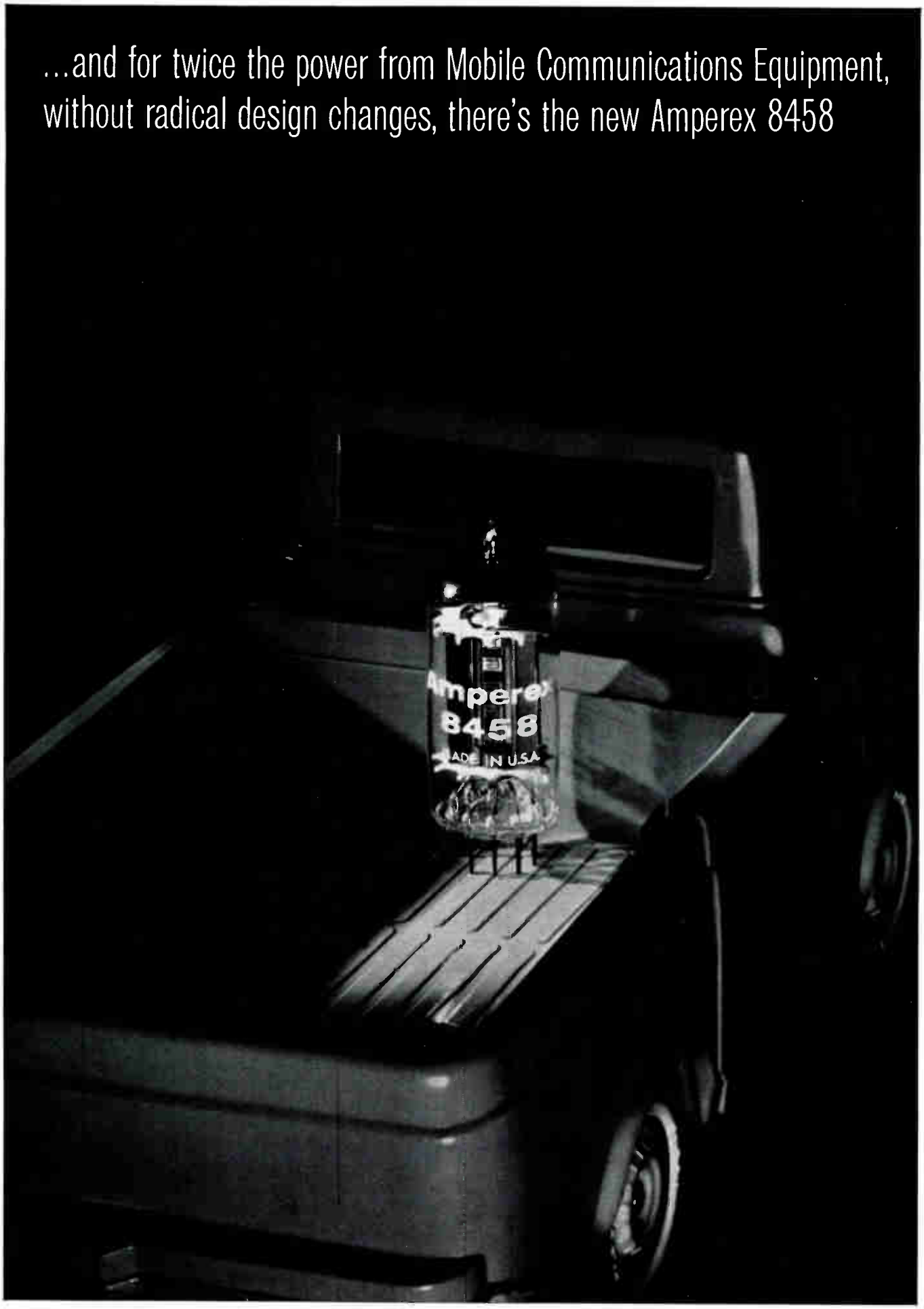
CIRCLE 24 ON READER-SERVICE CARD

We'll be pleased to forward full information on these and other materials that aid reliability and performance. Just write Dept. F309, Electronic Products Division, Dow Corning, Midland, Michigan.

Dow Corning

World Radio History

...and for twice the power from Mobile Communications Equipment, without radical design changes, there's the new Amperex 8458



World Radio History

If the world renowned Amperex 6360 is—as virtually all designers of mobile communications equipment agree—a truly great tube, its new derivative, the Amperex 8458 is an even greater one! For in addition to the great performance, great low-profile convenience, and great reliability of the earlier twin tetrode, the new 8458 can be counted on to deliver 30 watts of useful power at 175 Mc from less than 1.2 watts of drive power.

To drive the 8458, Amperex has developed a second new twin tetrode, the 8457, a 13.5 volt heater version of the 6360. It is ideally suited for use as a cascaded doubler-multiplier, driving the 8458 as a straight-through amplifier in the 150-175 Mc band. This combination of new Amperex tubes provides extremely stable power output under low voltage conditions, since more than sufficient drive is available. Because the profile heights of these two new tubes are identical with the older 6360, modification of existing circuit designs can be made with resulting improved power and performance.

Both tubes incorporate a 13.5 volt center-tapped heater; are internally neutralized and have indirectly heated oxide-coated cathodes.

8458
SIGNIFICANT CHARACTERISTICS
CLASS C RF AMPLIFIER AT 175 Mc

	CCS	ICAS
DC Plate Voltage	400	450 volts
DC Grid No. 2 Voltage	155	200 volts
DC Grid No. 1 Voltage	−59	−50 volts
DC Plate Current	85	110 ma
Useful Power Output	20	30 watts
Drive Power	1.0	1.2 watts

Both the 8457 and 8458 are immediately available in production quantities from stock.

For complete data on these and other Amperex tubes for mobile communications applications, write: Amperex Electronic Corp., Tube Division, Hicksville, L. I., New York 11802.

Amperex®

IN CANADA: PHILIPS ELECTRON DEVICES LTD., TORONTO 17, ONT.

Circle 53 on Inquiry Card

NEW PRODUCTS

VOLT BOX

Extends laboratory potentiometers for precision measurement up to 1500v.

Model 2851 is a 17 lb. instrument for rack mounting or bench use. It has separate working and guard circuits. Input working taps are 3, 7.5, 15, 30, 75, 150, 300, 750 and 1500v.; input guard taps are 15v. and above. Guaranteed error limit for the volt box is ±0.005%. Calibrated accuracy is ±0.002%. The instrument is thermally and electrostatically shielded. Honeywell, Denver Div., 4800 E. Dry Creek Rd., Denver, Colo.

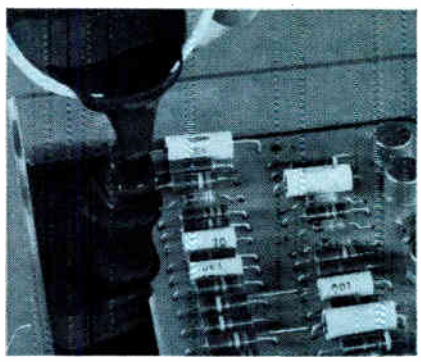
Circle 165 on Inquiry Card

POWER SIGNAL SOURCES

Direct-reading power ranges of 0-10 and 0-80w. over output band.

Models 470A-500 and 470A-1000 power signal sources generate strong, stable signals in the VHF-UHF region. They are used in testing and calibrating r-f filters, r-f detectors, receivers, and antennas. Model 470A has a freq. from 190 to 600 MC; Model 470A-1000 operates from 470 to 1000MC. They incorporate selective use of CW, sq.-wave, or pulse-modulated outputs, with 100% modulation being supplied either from an internal sq.-wave generator or from an external source. Sierra Electronic Div. of Philco, 3885 Bohannon Dr., Menlo Park, Calif.

Circle 166 on Inquiry Card



Authorized Distributors of Dow Corning electronic materials

Allied Radio Corporation
100 North Western Avenue
Chicago 80, Illinois — 312-TA-9-9100
- **Cleveland, Ohio** 4824 Turney Road — 216-883-5252
- **Dallas, Texas** 5622 Dyer Street — 214-EM-3-6221
- **Dayton, Ohio** 1823 Catalpa Drive — 513-278-5866
- **Denver, Colorado** 6767 East 39th Avenue — 303-399-2250
- **Detroit, Michigan** 16047 West McNichols Road — 313-836-0007
- **Milwaukee, Wisconsin** 2461 West Center Street — 414-HI-4-8320
- **Minneapolis - St. Paul, Minnesota** 730 East 38th Street — 612-TA-7-5401
- **Rochester, New York** 942 Monroe Avenue — 716-CH-4-8750
- **Washington, D.C. (& Baltimore)** 5509 Colorada Avenue, N.W. — 202-TU-2-6560

Brownell Inc.
85 Tenth Avenue
New York 11, New York — 212-WA-4-6000
- **Atlanta, Georgia** Brownell Inc. of Atlanta 690 Murphy Avenue, Southeast — 404-755-1681
- **Cambridge, Massachusetts** Brownell Inc. of New England 271 Vassar Street — 617-UN-4-7500
- **Charlotte, North Carolina** 3109 Cullman Avenue — 704-333-8426
- **Memphis, Tennessee** 217 Cumberland Street — 901-323-7693
- **Orlando, Florida** 307 27th Street P.O. Box 8553 — 305-GA-4-5634

Cramer Electronics, Inc.
320 Needham Street
Newton 64, Massachusetts — 617-WO-9-7700
- **Hamden, Connecticut** 60 Connelly Parkway — 203-AT-8-3581

The Huse Liberty Mica Company
Peabody Industrial Center
Peabody, Massachusetts — 617-JE-1-7100

E. V. Roberts and Associates, Inc.
5068 West Washington Boulevard
Los Angeles 16, California — 213-WE-8-2541
- **Culver City, California** EVRA Plastics and Chemicals Div. 3813 Hoke Avenue — 213-WE-8-2541
- **San Carlos, California** 1560 Laurel Street — 415-LY-3-7878
- **San Diego, California** 4379 30th Street — 714-AT-3-2149
- **Scottsdale, Arizona** 412 North Marshall Way — 602-WH-7-1381

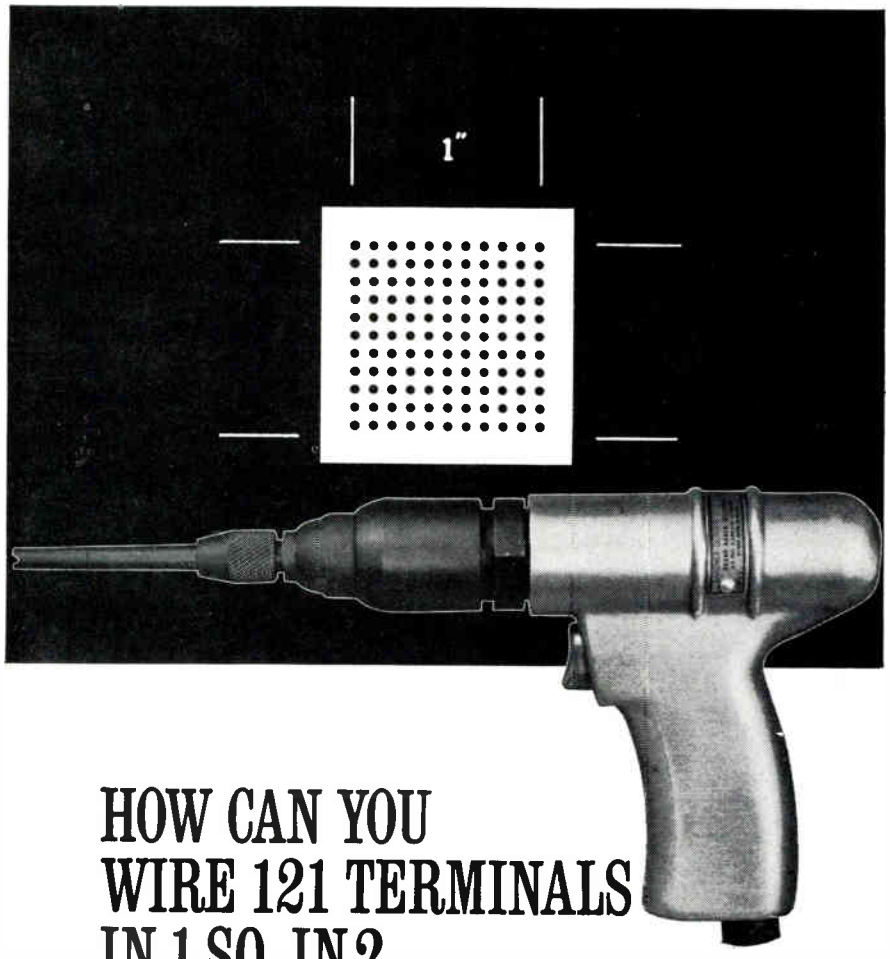
Sheridan Sales Company
10 Knollcrest Drive
Reading, Ohio
P. O. Box 37646 (Cincinnati) — 513-761-5432
- **Cleveland, Ohio** 6364 Pearl Road P. O. Box 7486 — 216-884-2001
- **Dayton, Ohio** 26 West Nottingham Road P. O. Box 37 — 513-277-8911
- **Lathrup Village, Michigan** 27305 Southfield Road P. O. Box 203 — 313-353-3822

Dow Corning

World Radio History

TO SEE WHAT AIR CAN DO SEE GARDNER-DENVER

In the sixties alone we have added hundreds of new and improved products to our lines of compressors, rock drills, air tools, drilling rigs. So before you invest in new air equipment, find out—from Gardner-Denver—how air can serve you better.



HOW CAN YOU WIRE 121 TERMINALS IN 1 SQ. IN.?

It is possible—and practical. Using 30- or 32-gauge wire, Gardner-Denver "Wire-Wrap"® tools make connections on 1/10" grid spacings. Newly designed miniaturized bits and sleeves make it possible. These attachments fit on present battery-powered or other "Wire-Wrap" tools.

High density packaging requires closely spaced terminals to meet industry's demands for smaller components in miniaturized equipment.

Connections made with "Wire-Wrap" tools are permanent. Proof: 15 billion solderless wrapped connections without a reported electrical failure.

For details on "Wire-Wrap" tools, write for Bulletin 14-1.

GARDNER-DENVER Since 1859

KEEP UP-TO-DATE WITH

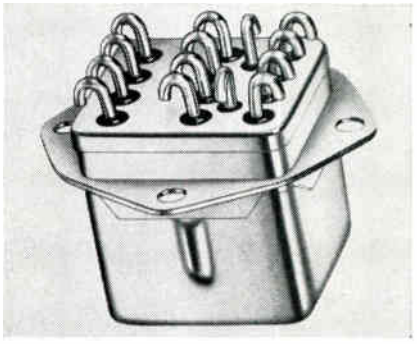
GARDNER-DENVER

Gardner-Denver Company, Quincy, Illinois

NEW PRODUCTS

MIDGET RELAY SWITCHES

The 4 pdt, 10a. unit is rated 3-phase, 115/200v., 400 cycles ac.

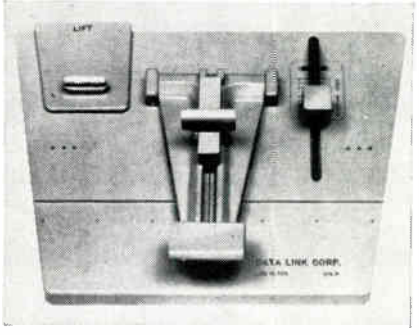


The 4005 inductive unit has a 1500v. RMS breakdown. It operates at −70°C to +120°C and handles a motor load of 5a. and lamp load of 3a. Internal solder connections have been eliminated. Max. operating or release time is 0.010 sec.; max. duration of contact bounce is 0.005 sec., normally closed, and 0.003 sec. normally open. Mechanical testing has exceeded 3 million operations. The unit meets Mil-R-6106-D requirements. Guardian Electric Mfg. Co., 1550 W. Carroll Ave., Chicago, Ill.

Circle 167 on Inquiry Card

PAPER-TAPE ACCESSORY

Combines a splicer, gauge and punch in a single console for quick processing.



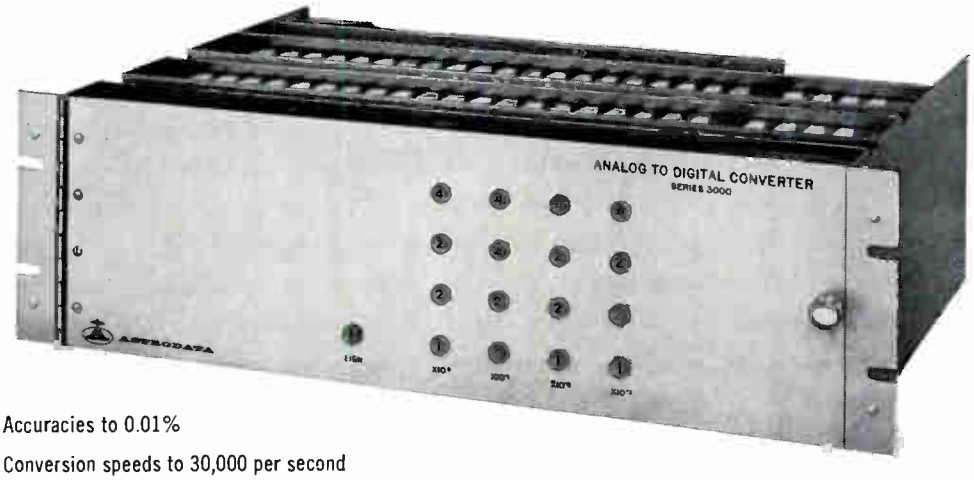
This compact unit allows processing punched paper tape quickly and economically with perfect registration using any form of splice, while at the same time correcting coding errors or punching special codes. A tape gauge aligns and registers the tape, preventing reprocessing. The manual tape punch allows perforating one or more bits at any point on the tape. Error codes and code changes can be punched without refeeding the tape. It can be used with 5, 6, 7, and 8-channel punched tapes. Data-Link Corp., 4546 El Camino Real, Los Altos, Calif.

Circle 168 on Inquiry Card

World Radio History

ASTRODATA

MORE THAN 1,000 STANDARD ADC's FROM A LIBRARY OF 13 BASIC CARDS

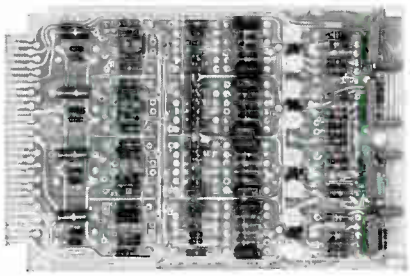


- Accuracies to 0.01%
- Conversion speeds to 30,000 per second

Astrodata low cost Series 3000 Analog-to-Digital Converters meet the requirements of virtually all data acquisition systems with 1088 standard production models. From these you can select the full scale range . . . speed . . . accuracy . . . sample-and-hold . . . resolution . . . output format best suited to your specific system.

Designed for easy integration into existing or new data acquisition systems, standard features include individually buffered data output lines . . . adjustable output logic levels (clamped) . . . wiring installed for future addition of input amplifier or sample-and-hold circuits . . . front panel readout of data (including polarity) . . . and isothermal environment of converter network and reference voltage diode to assure maximum accuracy over wide temperature range.

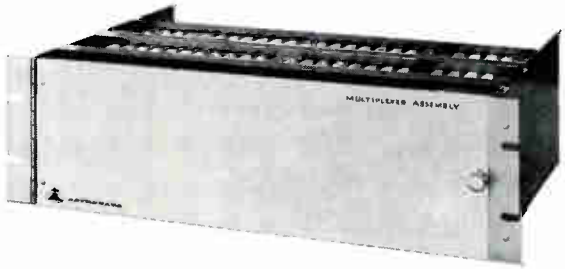
Series 3000 ADC's ideal for use with time-multiplexed input data



HIGH LEVEL MULTIPLEXERS

Model 155-83 low cost, high-level-input multiplexer module has been developed for high speed analog switching applications.

Inputs per card	6 one-wire or 4 two-wire
Input Voltage	±5 volts
Switching Time	<5 μsec
Crosstalk	±0.01%
Input Impedance	1000 megohms/number of switches in multiplexer group



MULTIPLEXER ASSEMBLIES

Series 950 multiplexer assemblies consist of cards, shown at left, for single ended channels in multiples of 6 or differential channels in multiples of 4. Power supply and output buffer amplifier are included. Channel identification data can be furnished in binary or BCD form. The multiplexer channels can be addressed directly by computers or advanced sequentially to meet the requirements of specific systems applications.

17

Contact your nearest Astrodata representative today for a demonstration or write for technical literature giving complete specifications.

ASTRODATA INC.
240 E. Palais Road • Anaheim, California

World Radio History

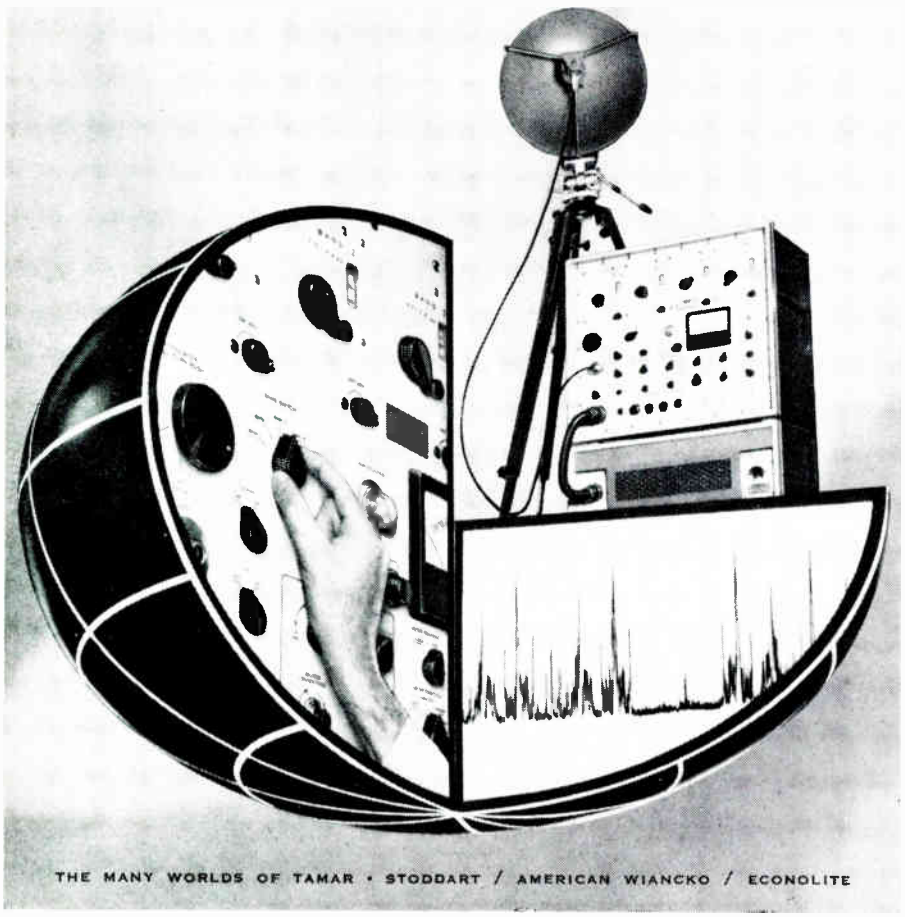
full time assistant for RFI analysis

Automation has come to RFI analysis. Stoddart's new NM-62B, covering the frequency range from 1-10 gc in four bands, scans the full range or any selected portion, switching bands automatically. Based on a "set it, leave it, read it" philosophy, the NM-62B can be programmed with extreme versatility, and virtually amounts to a full-time assistant who never makes mistakes or needs a vacation.

Specifically designed for RFI specialists by RFI engineers, the NM-62B features advancements to warm the cockles of any RFI man's heart. In addition to being fully automatic, the NM-62B provides direct peak measurement for any type of signal; remote data display capability; a 160 mc i-f output for use with panoramic adaptors; new, simplified two-step calibration; and a unitized power supply. No plug-in units or tack-on gadgets, naturally. Like other Stoddart RFI equipment, the NM-62B meets or exceeds all applicable military specifications, and is ideal for use in industrial applications.

For complete details on the NM-62B and other advanced RI-FI measuring equipment, write or call Stoddart Aircraft Radio Co., 6644 Santa Monica Boulevard, Hollywood 38, California. Phone: (213) HOllywood 4-9292. A subsidiary of Tamar Electronics, Inc.

STODDART

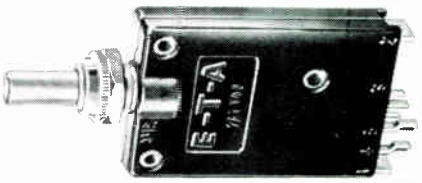


THE MANY WORLDS OF TAMAR • STODDART / AMERICAN WIANCKO / ECONOLITE

NEW PRODUCTS

MINIATURE CIRCUIT BREAKER

Available from 0.05 to 15a., 240vac and 24vdc.



Series 46-400 miniature circuit breaker has 2 auxiliary contacts—NO and NC. The auxiliary contacts can give an indication by light or buzzer, or they can be used to connect or disconnect other components such as relays, solenoids, etc., when the breaker is in the on or off position. Size: 2 x 0.5 x 1.2. E-T-A Products Co. of America, 6284 N. Cicero Ave., Chicago, Ill.

Circle 197 on Inquiry Card

ETCHING & PC TEST STANDARDS

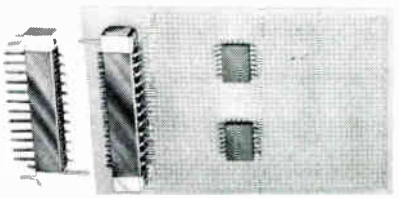
For printed circuits, chemical blanking, and micro-image etching.

Three special precision negatives are available to test exposure time, resist development, etch rates, undercutting, and other factors involving chemical etching of parts and circuits. One negative, which is offered free, is intended for PC uses. It contains a variety of test patterns with widths down to 0.005 in. Chemical Micro Milling Co., 105 S. 7th St., Phila., Pa.

Circle 198 on Inquiry Card

PLUGBOARDS

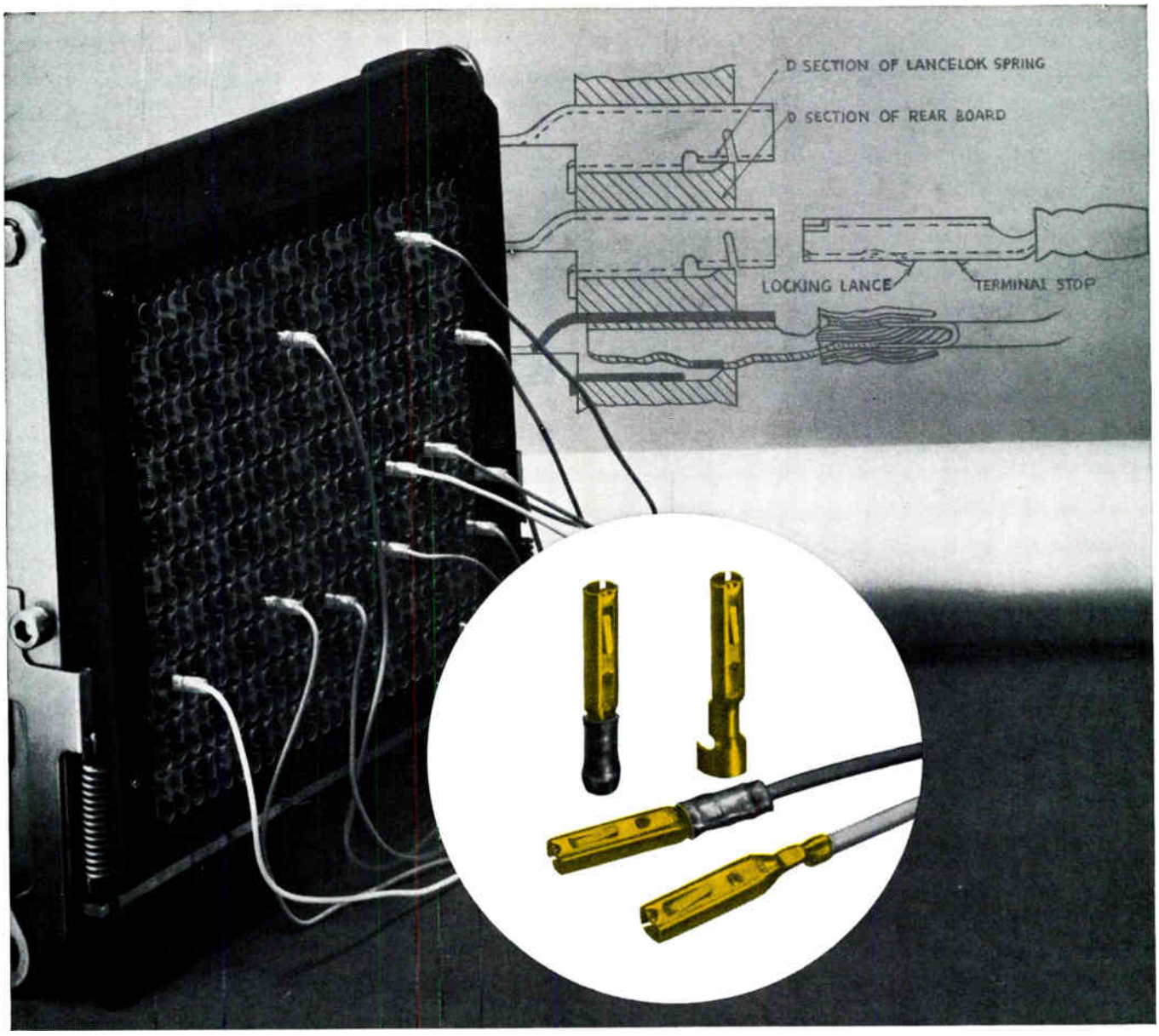
For fabricating short runs, prototypes, and plug-in mounts.



These plug-in boards, for integrated-circuit fabricating, are 1/32 in. thick prepunched epoxy glass with 0.025 in. dia. holes on 0.05 in. C-to-C spacing, or 0.042 in. dia. holes on 0.1 in. spacing. Plugboards have micro-miniature connector with 9, 12, or 15 contacts. Matching receptacles for mother board mounting are also offered. Vector Electronic Co., Inc., 1100 Flower St., Glendale, Calif.

Circle 199 on Inquiry Card

World Radio History



Better wire your back bay . . . this way

Our new LANCELOK★ terminal *is* the better way. It's designed to perform better with increased contact areas for maximum conductivity. An integral lance locks it in to stay. No calibrated tool is necessary for insertion. A simple extraction tool makes circuit changes and repairs easy. And insulated and uninsulated LANCELOK terminals are provided loose piece, or tape mounted for automatic application.

Because of its special design, there's no chance to over-insert a LANCELOK terminal. A positive stop in the terminal body takes care of that! And there's no chance at all for incorrect installation—positive "D" shaped polarization assures quick, correct assembly.

Once locked in, minimum retention force between terminal and programming spring is 20 pounds. That's more than enough to assure top reliability under maximum shock and vibration in missile launching, fast-flying aircraft, automated assembly lines and other advanced patchcord programming applications.

Other important features include:

- Superior electrical performance
- Minimum of 15 insertions and extractions without electrical or mechanical changes
- Both insulated and uninsulated types available
- Pre-insulated type meets tensile and dielectric requirements of MIL-T-7928
- Gold over nickel plating

Get the facts on the *better* way for back-bay wiring. Write for complete details on the new LANCELOK terminal today.

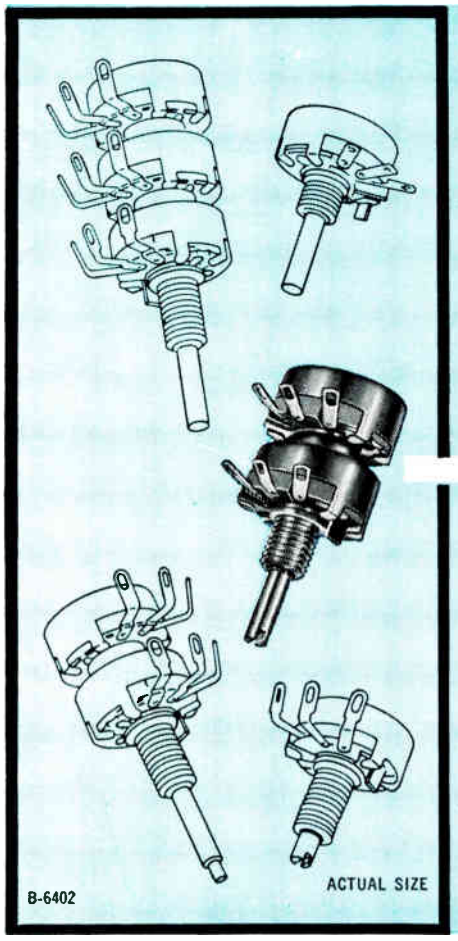
★Trademark of AMP INCORPORATED

AMP INCORPORATED
Harrisburg, Pennsylvania

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

World Radio History



5/8" Potentiometers

MILITARY OR COMMERCIAL

CENTRALAB HAS 9 TYPES OF EACH

Composition or wirewound, in singles, twins, triples, dual concentrics or attenuators*... RV1 Style MIL-R-94B composition, or wirewounds to MIL-R-19A performance specifications, or their commercial equivalents, all available at realistic prices and delivery schedules.

Ratings: Composition, 1/4W at 70°C, zero at 120°C per MIL-R-94B
Wirewound, 2W at 70°C, zero at 135°C per proposed MIL-R-39002

Ranges: Composition, linear 200Ω to 5.0 meg, 10% log 5000Ω to 2.5 meg
Wirewound, 4 to 30,000Ω linear taper

For immediate delivery many types are stocked by Centralab Industrial Distributors as JMP, JML, JWP, JWL series.
Write for detailed engineering data.

*not available as wirewounds

Centralab®

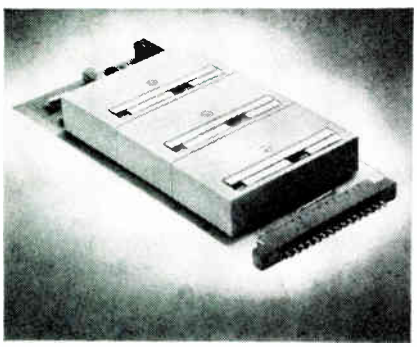
THE ELECTRONICS DIVISION OF GLOBE-UNION INC.
P.O. Box 591, Dept. 381 • Milwaukee, Wisconsin 53201
In Canada: Centralab Canada Ltd., P.O. Box 400, Ajax, Ont.

Circle 103 on Inquiry Card

NEW PRODUCTS

AMPLIFIER

Features a gain of 10^8 with 1μv./°C stability; input impedance, 1 megohm.

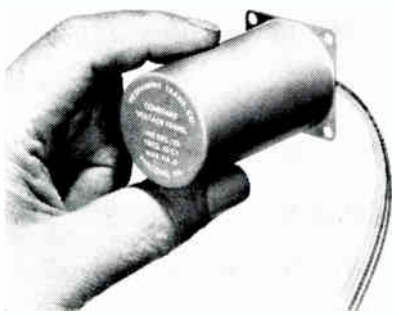


Model 141 offers an output range of ±20v. and 20ma from dc through 125KC. A slewing rate of 15v./μsec. makes the amplifier suited for use in fast D/A conversion systems. Freq. response is 1MC at unity gain. Other specs. include offset error current of less than 10^{-11}a. Other versions are available offering different output ranges. Zeltex Inc., Concord, Calif.

Circle 182 on Inquiry Card

MINIATURE TRANSFORMER

Constant-voltage unit has an output of 0.6v-a @ 5v. RMS.

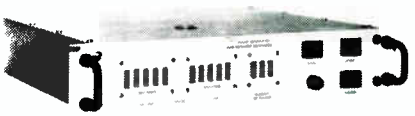


Model MCV-1 measures 2-7/16 in. long x 1-25/64 in. dia. Output voltage regulation is within ±1% RMS vac, with input voltage fluctations from 95 to 130v. Developed as a substitute for the solid-state voltage reference sources used in compact instrumentation systems, the transformers remain stable over a wide temp. range. Neshaminy Transformer Corp., Furlong, Pa.

Circle 183 on Inquiry Card

PULSE-TRAIN GENERATOR

Provides pulse trains of 1 to 999 pulses. Timing accuracy to ±1.5% to 1msec.



Model 91645 has variable pulse widths and pulse separations from 1msec. to 99,-999 sec. The 3a. solid-state output switching circuit protects against overload and surge due to inductive loads. It has uses in programming, sequencing, testing data processing, timing and system applications requiring repetitive, accurate pulse generation. Tempo Instrument Inc., E. Bethpage Rd., Plainview, L. I., N. Y.

Circle 184 on Inquiry Card

World Radio History

VOICE MULTIPLEX TERMINAL

Provides 12 toll quality voice channels in the freq. band of 4 to 60KC.

The voice channels of Model 2710 Voice Multiplex Terminal may be applied individually or in groups. Each channel is equipped with its own individual crystal oscillator and no common equipment is required. Voice terminations are available on a 2-wire or 4-wire basis by simple plug option. Front panel jacks and adjustments are provided for measuring and adjusting all key parameters. Radio Frequency Laboratories, Inc., Communications Equipment Div., Boonton, N. J.

Circle 185 on Inquiry Card

TRANSFER RELAY

Offers vacuum dielectric in a 4-pole (2 inputs, 2 outputs) configuration.

The switch contacts of RC53 are enclosed in the high-strength vacuum which eliminates corrosion or oxidation. This also stops noise generation and intermodulation due to the rectification of the r-f signal. The 26.5vdc actuator is latching type with permanent magnets to maintain switch position. Freq. range is 0-600MC. Power rating is 5kw CW average at 30MC. Crosstalk is greater than —70db at 60MC; VSWR is 1:1.1 max. through 600MC. Jennings Radio Mfg. Corp., P. O. Box 1278, San Jose, Calif.

Circle 186 on Inquiry Card

FIXED COILS

Miniature shielded fixed coils offers Q ratings averaging 75.

Designers can expect more from small molded coils and even use them in place of toroids, thus saving space due to smaller packaging and greater economies in cost. The electromagnetic shielding in the 1537-800 series is fully effective not only along the entire body but also at each end as well. The length of the molded body permits lead mounting of 0.400 in. PC hole spacing. Specs are: size, 0.57 in., dia., 0.375 in. length; shielding, less than 2% coupling; inductance, 0.1μh thru 10,000μh (80 values); and environment, Grade 1, Class B, Mil-C-15305. Delevan Electronics Corp., 270 Quaker Rd., East Aurora, N. Y.

Circle 187 on Inquiry Card

SOLID STATE RELAY

No moving parts or contacts; time delays from 100μsec. to 100sec.

The ST Series is for use where extreme acceleration, shock and vibration are encountered. Relay is a SPST, normally open or normally closed unit. Life expectancy is 10^6 operations. Reset time following deenergization is 25μsec. Standard operating voltage is 28vdc. Units can be furnished for operation at any nominal voltage from 10 to 30vdc, or voltage compensated over 33% of input voltage. Electronic Fittings Corp., 29 Sugar Hollow Rd., Danbury, Conn.

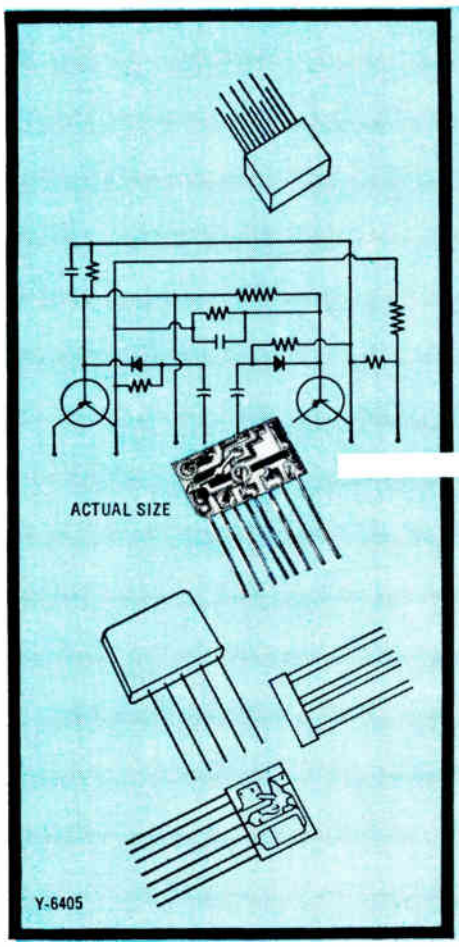
Circle 188 on Inquiry Card

PRINTER

Tailored for card-, paper tape-, or magnetic tape-to-printer.

Dial-o-verter Model D401 alpha-numeric printer is used with the new Reverse Channel Data-Phones. It is a high-speed on-line printer with a double-bucket buffer which provides simultaneous printing and data transmission. It has a 120 column printhead. The effective printing rate is up to 300 lines/min. It offers full error-checking of input data. Retransmission requests are initiated automatically whenever errors in the received data are detected. Digitronics Corp., Albertson, N. Y.

Circle 189 on Inquiry Card



Thin-Film PEC® Integrated Circuits

AVAILABLE NOW FROM CENTRALAB

Proven and practical, here and now—Centralab PEC Integrated Circuits with active and passive components. More than a quarter of a billion have been used in two decades of military and commercial application.

PEC's offer you these advantages: Complete flexibility of form and circuit design, extremely high reliability, ability to include a wide variety of components and values, simple interconnections, costs comparable to and frequently lower than discrete components.

Centralab offers you these advantages: Complete engineering assistance, ability to supply integrated circuits in production quantities, realistic delivery schedules.

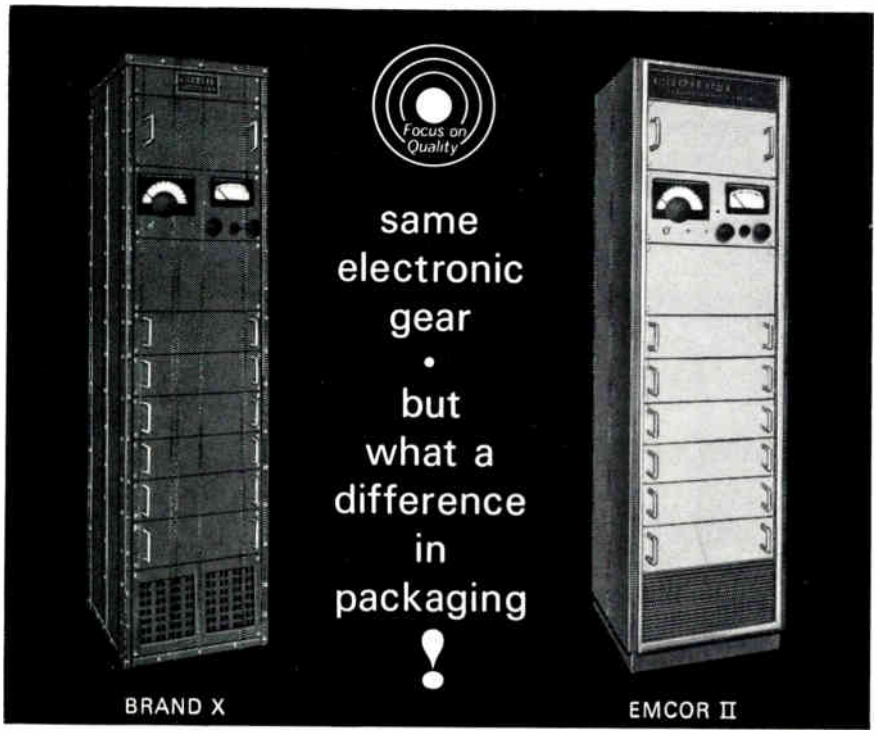
Write for Centralab's brochure, PEC Basic Data.

Centralab®

THE ELECTRONICS DIVISION OF GLOBE-UNION INC.
P.O. Box 591, Dept. 381 • Milwaukee, Wisconsin 53201
In Canada: Centralab Canada Ltd., P.O. Box 400, Ajax, Ont.

Circle 61 on Inquiry Card

World Radio History



EMCOR II MODULAR ENCLOSURES MAKE THE DIFFERENCE!

EMCOR Modular Enclosures give your product or system the face and look of quality. More than icing on the cake in physical appearance, EMCOR II Enclosures support the styling with rugged structural construction and functional flexibility not available in custom type or other marketed enclosures. There's a reason for the difference. Choice of enclosure configurations and lines, simplified catalog specifying and ordering, reduction of your needless enclosure design time, elimination of costly tooling, production and intermittent plant operations make the difference. Discover the EMCOR II Enclosure difference for yourself. Phone for full details from your local EMCOR Sales Engineering Representative listed below or write for literature—no obligation.

Seattle: 722-7800; Los Angeles: 938-2073; Palo Alto: 968-8304; La Jolla, Calif.: 454-2191; Dallas: 631-7450; Houston: 526-2959; Tulsa: 742-4657; Orlando: 425-5505; Washington, D. C.: 836-1800; Huntsville: 536-8393; Winston-Salem: 725-5384; Ft. Lauderdale: 564-8000; Boston: 944-3930; Bridgeport: 368-4582; Albany: 436-9649; Buffalo: 632-2727; Binghamton: 723-9661; Syracuse-Utica: 732-3775; New York City: 695-0082; Union City, N. J.: 867-3204; King of Prussia, Pa.: 265-3440; Detroit: 357-3700; Cleveland: 422-8080; Dayton: 298-7573; Pittsburgh: 884-5515; Chicago: 676-1100; Indianapolis: 356-4249; Minneapolis: 545-4481; St. Louis: 647-4350; Kansas City: 444-9494; Denver: 934-5505; Albuquerque: 265-7766; Centerville, Utah: 295-6521.

EMCOR Enclosures by...

INGERSOLL PRODUCTS

Division of Borg-Warner Corporation

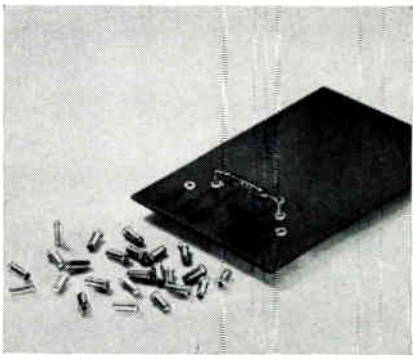
1000 West 120th Street • Dept. 1239, CHICAGO, ILLINOIS 60643

electronic equipment BORG WARNER

NEW PRODUCTS

TEST RECEPTACLES

Prevents head damage during burn-in testing by eliminating soldering.

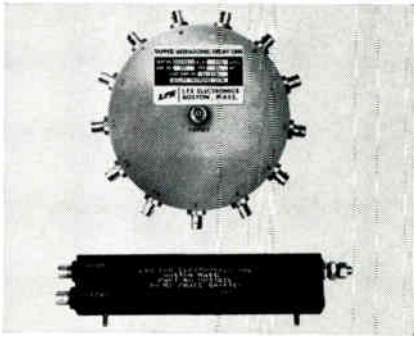


These 3 types of reusable component test receptacles are for testing PC board components. The standard closed-bottom type have gold-plated and tin-plated interiors. The third type is an open-bottom jack that accepts component leads from either side of the board. Once in place, receptacles accept hand-inserted component leads from 0.018 to 0.040 in. in dia. When the burn-in is completed, component leads are hand removed from the receptacles which are then ready to accept a new lead. AMP Inc., Harrisburg, Pa.

Circle 169 on Inquiry Card

DELAY LINE PACKAGE

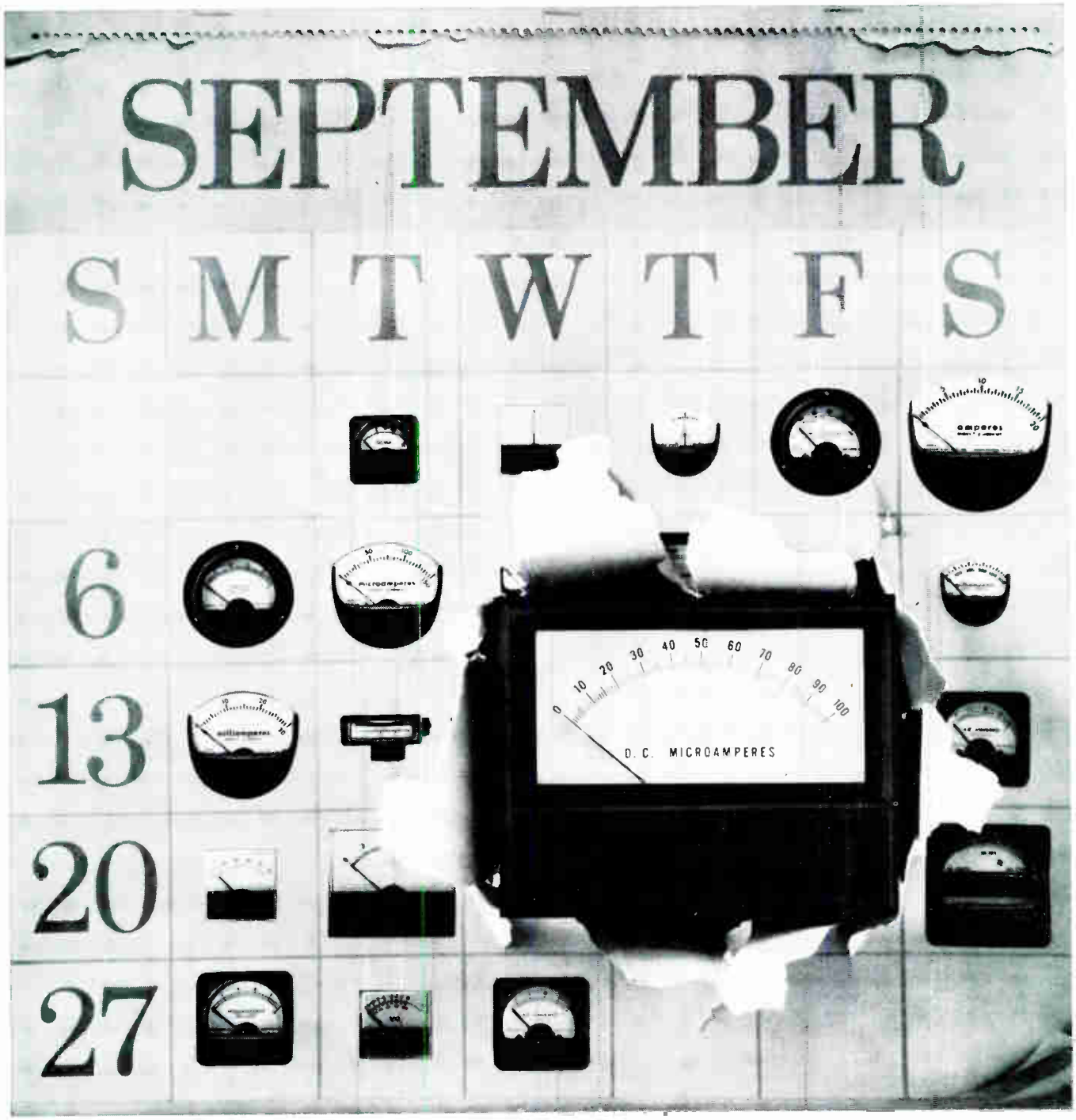
Thirteen taps range from 0.500μsec. to 6.5μsec. in 0.500μsec. steps.



This ultrasonic delay-line multi-package has an attenuation of 45db (±1db) into 75Ω. Delay tolerance is ±10nsec. Spurious signals, triple travel and feed thru are 35db min. below the main signal. Nominal center freq. is 30MC. Operation in a digital system with no r-f carrier is possible. The variable phase shifters provide up to 360° of additional phase shift, and permit setting of delays to within a fraction of a nsec. to compensate for circuit and cable delays. Laboratory for Electronics, Inc., 1079 Commonwealth Ave., Boston, Mass.

Circle 170 on Inquiry Card

World Radio History



Meter of the Month—the new Honeywell picture-frame "45"

The picture-frame Model 45 by Honeywell brings fresh, modern styling to the traditional rectangular meter. This new 5-inch meter is available with pivot and jewel or taut-band mechanism. Thermosetting plastic cover is dull black with 2-color styling optional. Standard ASA four-hole, front-of-panel mounting; all standard AC and DC current and voltage ranges. ■ Honeywell makes quality meters in every shape and size imaginable. Order direct from the Honeywell stocking distributor nearest you. For his name (and more information on the new "45"), write: Honeywell Precision Meter Division, Manchester, N.H. 03105. In Canada, Toronto 17, Ontario.

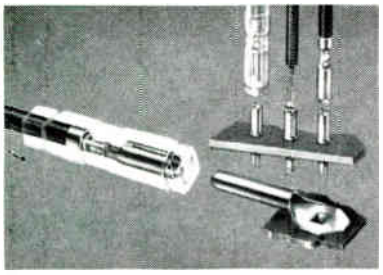
Honeywell

World Radio History

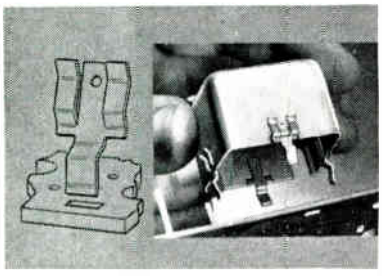
Malco

MOST COMPLETE LINE OF ELECTRONIC HARDWARE

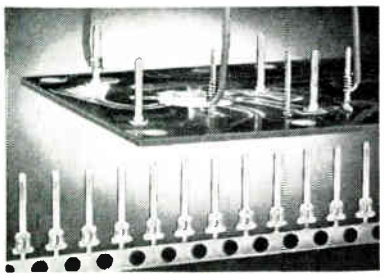
- Low Cost
- Fast Delivery
- Uniform Quality



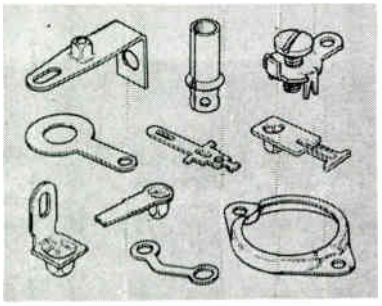
PIN TERMINALS
RECEPTACLES·DISCONNECTS



SPRING CLIPS



WRAP-A-WIRE TERMINALS



LUGS AND TERMINALS

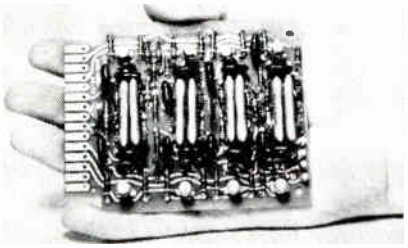
REQUEST BULLETIN NO. 612.
SEND B/P OR SPECS.
FOR QUOTATION.

Malco MANUFACTURING COMPANY, INC.
4037 W. LAKE ST., CHICAGO, ILLINOIS 60624
Circle 59 on Inquiry Card

NEW PRODUCTS

DECADE COUNTER

Counting rate is 2MC; max. reversing delay time is 1μsec.

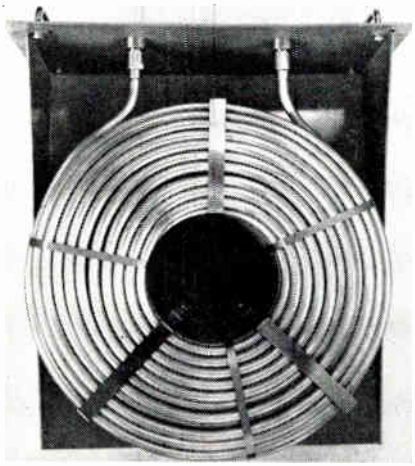


Model B100-80 forward-backward counter provides arbitrary setting of output voltage level. This makes it possible to use the counter in conjunction with a wide variety of logic control levels. It is an integrating-type counter that accumulates the net count of all input signals presented to both the forward and backward inputs. An 8-4-2-1 binary-coded decimal counting technique provides a single output pulse for every 10 accumulated net pulses. Janus Control Corp., Hunt St., Newton 58, Mass.

Circle 171 on Inquiry Card

DELAY LINE

For calibration of oscilloscopes, altimeters, and radar systems.



This coaxial-cable delay line is fabricated from ½ in., 50Ω Foamflex. Type NF panel-mount connectors are provided on this standard unit. The delay line offers a standard delay of 500nsec. (±0.25 nsec.). Attenuation ranges from 17.5 to 30db over a freq. range from 2.0 to 4.0GC. Under the same parameters, max. VSWR is approx. 1.15. Phelps Dodge Electronic Products Corp., 60 Dodge Ave., North Haven, Conn.

Circle 172 on Inquiry Card

DORMEYER
DOUBLE D
REED
RELAYS

COMPLETE RELIABILITY
HIGH SPEED SWITCHING
LONG LIFE EXPECTANCY

CUSTOM DESIGNED
TO SUIT YOUR CIRCUIT
REQUIREMENTS

•

SEND US YOUR
SPECIFICATIONS OR
REQUIREMENTS

Write For Brochure

DORMEYER INDUSTRIES
3442 No. Milwaukee Ave., Chicago, Ill. 60641
SOLENOIDS • TRANSFORMERS • COILS • RELAYS

DORMEYER Dependability

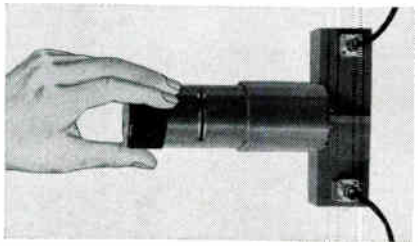
Circle 60 on Inquiry Card

World Radio History

NEW PRODUCTS

FREQUENCY METER

Operates in 3.3 to 4.9GC range. Bandwidth, 0.5MC; cavity Q is 8000.



Type TR-82079 is used in radio, telephone, and TV communications design. Unit is direct reading, with sub-division every 2MC. It is calibrated every 50MC. Accuracy is 0.03%. Input and output connections may be CMR-229 flanges, coaxial or a combination of both. Electronic Specialty Co., 5121 San Fernando Rd., Los Angeles, Calif.

Circle 203 on Inquiry Card

DIELECTRIC RESINS

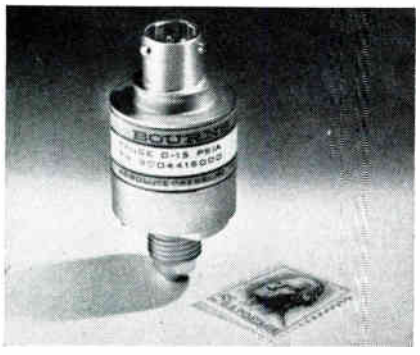
Thermal conductivities at least 10 times those of conventional filled resins.

The Berlon composite materials include epoxies, phenolics, and silicones filled with Berlox high-purity beryllium oxide. Beryllium oxide provides increased thermal conductivity in the resins, while dielectric strength, volume resistivity, and power factor are maintained. National Beryllia Corp., Haskell, N. J.

Circle 204 on Inquiry Card

PRESSURE TRANSDUCER

Delivers a stable output up to 35G vibration and 50G shock.



Model 441 operates over pressure ranges of 0-5 to 0-450 psia. Flex-pivot construction virtually eliminates mechanical friction and enables resolution of 0.5%. Other features include ultra-reliable potentiometric elements; hermetic seal construction; and optional LOX-clean compatibility in all pressure ranges. Bourns, Inc., 1200 Columbia Ave., Riverside, Calif.

Circle 205 on Inquiry Card

BAND-PASS/HIGH-PASS FILTER

Independent tuning of low- and high-cutoff freqs. from 20 CPS to 200KC.

Model 312 has front-panel switch which permits operation in the high-pass mode. This eliminates the upper cutoff freq. and extends the pass-band to 4MC. Attenuation rate is 24db/octave beyond the cutoff freqs. with pass-band gain of 0db to ±1db. Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge, Mass.

Circle 206 on Inquiry Card

PELLET RESISTORS

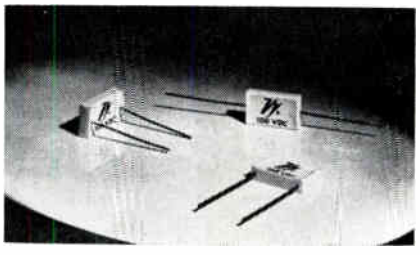
SWR measurements made with a 50Ω pellet indicate less than 1.1 at 1200MC.

These pellet film resistors feature a fluted design in dia. of 0.100 in. and thicknesses of either 0.030 or 0.063 in. Pellets have a low standing-wave ratio when used as r-f terminations, and fast rise time when used in pulse applications. P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis, Ind.

Circle 207 on Inquiry Card

PORCELAIN CAPACITORS

Offers a choice of capacitance, capacitance tolerance, and temp. coefficient.

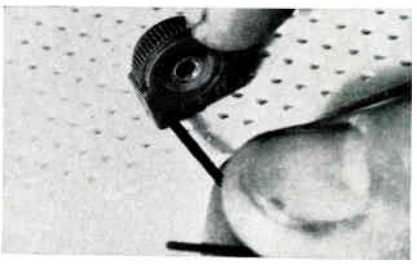


The thin-line series features: capacitance ranging from 0.5pf to 10,000pf; temp. coefficients of 0 (±25 ppm/°C) and 105 (±25 ppm/°C); axial, face radial, or edge radial lead configurations. Insulation resistance is greater than 100,000 megohms; capacitance is stabile over a freq. range from 1KC to 1MC. Vitramon, Inc., Box 544, Bridgeport, Conn.

Circle 208 on Inquiry Card

TRIMMING POT

Dual-adjustment feature provides greater mechanical and electrical resolution.



Model 333 trimming potentiometer offers dual adjustment — a single-turn knurled knob for finger-tip adjustment and an Allen-wrench fine adjustment with a 4:1 ratio. It is available in resistance values of 50Ω to 10KΩ. Resistance tolerance is ±10%. Weston Instruments, Inc., Weston-Archbald, Archbald, Pa.

Circle 209 on Inquiry Card

FOUR-LAYER DIODES

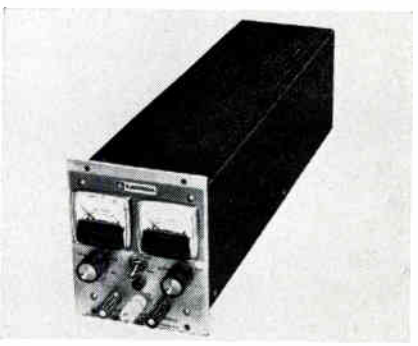
Switching voltage range of 5v. to 20v.; holding currents 0.1ma to 60ma.

The WF series of planar-passivated PNPN 4-layer diodes have a forward and reverse leakage of 2 to 5 nanoamp. They operate from −60° to +150°C, and have a rated 250mw dissipation. Units are contained in a hermetically sealed glass package. Western Semiconductors Inc., 2200 S. Fairview St., Santa Ana, Calif.

Circle 210 on Inquiry Card

POWER SUPPLIES

Multiple current supplies have voltages to 60vdc. Line regulation, 1mv.



The LH series are available in ¼ and ½ rack sizes. Each model has multiple current ratings which vary with the amb. temp. They are remotely programmable over current and voltage range. Both models have a wide input voltage and freq. range — 105-135vac, 45-480 CPS. Lambda Electronics Corp., 515 Broad Hollow Rd., Melville, L. I., N. Y.

Circle 211 on Inquiry Card

World Radio History

Simple, Accurate Way To

MEASURE LINEAR VELOCITY

Sanborn LVsyn® transducers are rugged, low cost and easily applied. Output voltage varies linearly with core velocity. No excitation voltage required. Thirteen standard models available with regular or non-breakable magnet cores — inquiries on "specials" invited.

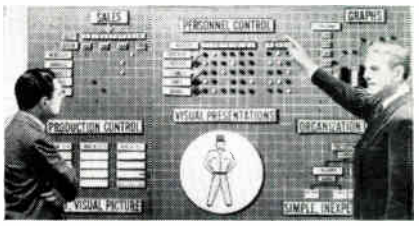
- Working stroke ranges 0.5″ to 20″
- Outputs 7 to 650 mv/inch/sec.
- Linearity better than 1%
- Low friction (zero when mtd. vertically)
- Immersible; temp. range —50° to 200°F.
- No end stops required
- $40 to $120 (FOB Waltham, Mass.)

Bulletin & Application Data on Request

TRANSDUCER DIVISION
SANBORN COMPANY
175 Wyman St., Waltham 54, Mass.
A Subsidiary of Hewlett-Packard Company

Circle 62 on Inquiry Card

VISUAL MAGNETIC CONTROL



MAGNETS MOVE FASTEST—AND EASIEST—OF ALL

SIMPLEST VISUAL CONTROL FOR

Sales • Production • Personnel
Maintenance • Machine Loading • Scheduling
Charts • Visual Presentations • Graphs

COLORFUL MAGNETIC ELEMENTS

ORGANIZE FOR ACTION
SHOW FACTS INSTANTLY
ELIMINATE MISTAKES
GET THE JOB DONE

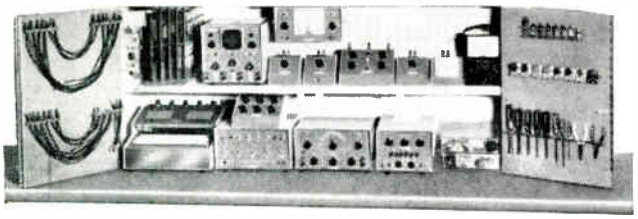
Priced From
$38.00
Including Magnetic Elements

Price List & Brochure #EI-9
FREE
On Request

Methods Research Corp.
105W-Willow Ave., Staten Island, N.Y. 10305

Circle 64 on Inquiry Card

A HEATH-BUILT ELECTRONICS LAB FOR RESEARCH & EDUCATION



(Available As A Coordinated System Or As Individual Units)

Complete Lab Station $1100 (less optional cabinet)

Educators and researchers will find this lab station the most modern and complete group of its type in the industry today! Designed by Heath in close association with Dr. H. V. Malmstadt of the University of Illinois and Dr. C. G. Enke of Princeton University, the EU Series provides researchers in both the physical and life sciences a solid foundation in the principles, design and use of electronic instrumentation plus the highly accurate equipment necessary for their work. The system includes factory assembled & calibrated test equipment, special purpose lab instruments, special experimental groups featuring "solderless" spring-clip connectors and the authoritative Malmstadt-Enke text "Electronics for Scientists." Send for Free brochure today for complete details!

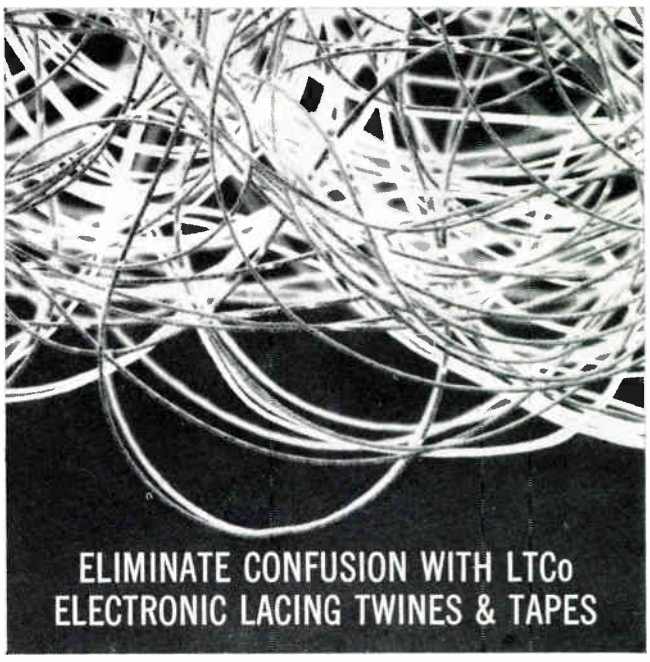
HEATHKIT

HEATH COMPANY, Dept. 53-9-1
Benton Harbor, Mich. 49023

☐ Please send free 8-page EU-100 Brochure.
☐ Please send free 100-page Heathkit Catalog.

Name_____
Address_____
City_____ State_____ Zip_____
EK-160

Circle 63 on Inquiry Card



ELIMINATE CONFUSION WITH LTCo ELECTRONIC LACING TWINES & TAPES

LTCo cords and tapes simplify circuits. Choose from a variety of natural and synthetic fibers: nylon, teflon, linen, cotton and polyester. Free brochure describes put-ups, constructions and finishes. Write:

THE LINEN THREAD CO.
Blue Mountain, Alabama
A DIVISION OF INDIAN HEAD MILLS, INC.

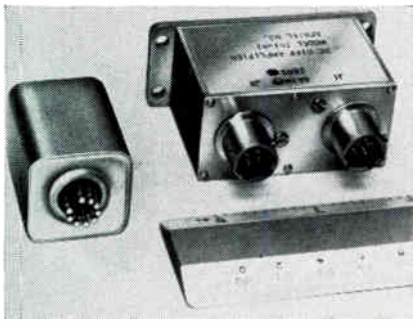
Circle 65 on Inquiry Card

World Radio History

NEW PRODUCTS

LINEAR AMPLIFIER

Input impedance is greater than 200KΩ and output impedance is 50Ω.

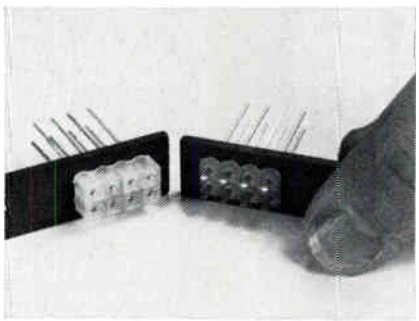


The FA1-A1 provides a ±5vdc (or 10v.) full-scale output from the low mv signals originating from strain-gage type transducers. Continuously adjustable zero balance and gain from 20 to 1000 is available. It contains a highly regulated transducer power supply, reverse polarity protection, input-output isolation and RFI filter. Fairchild Controls, Div. of Fairchild Camera and Instrument Corp., 225 Park Ave., Hicksville, N. Y.

Circle 173 on Inquiry Card

CONNECTORS

Can be wired by programmed automatic wrapping machines with savings to 50%.

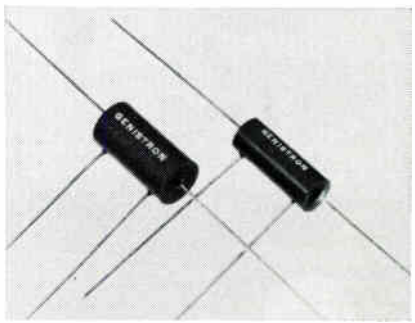


The Mini-wrap® connectors have terminations on 0.100, 0.125, and 0.150 in. centers. Connection failures average less than 1 in 500,000. Wire-wrap® connections resist corrosive atmosphere, severe shock and vibration. Connectors can be designed for rack-and-panel, patchboard, motherboard, PC or special, small-odd-shape uses. Amphenol, Div. of Amphenol-Borg Electronics Corp., 1830 S. 54th Ave., Chicago, Ill.

Circle 174 on Inquiry Card

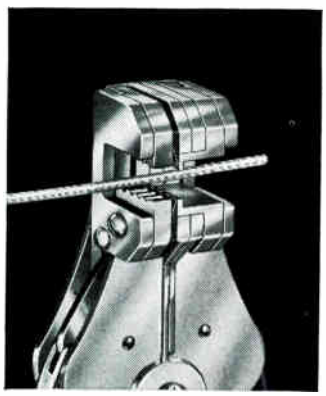
FOUR-TERMINAL RESISTORS

Virtually eliminates lead and contact resistance.

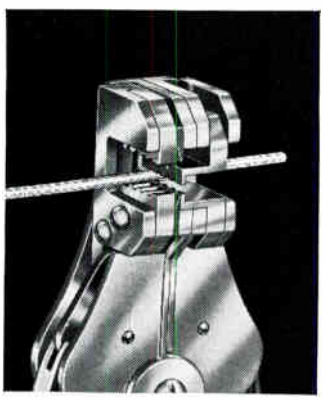


These 4-terminal resistors allow the total resistance value to be controlled. In place of the actual circuit resistance being determined by the resistance of the unit and its leads, as in 2-terminal resistors, the 4-terminal resistor eliminates the lead and contact resistance variables. The resistors can be supplied in tolerances to 0.005%. Standard temp. coefficient is 10 ppm. Genistron, Inc., 6320 W. Arizona Circle, Los Angeles, Calif.

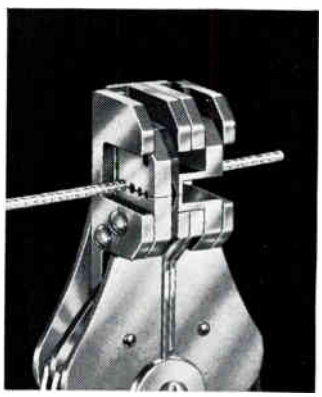
Circle 175 on Inquiry Card



1. Place wire in proper collet-blade hole.



2. Squeeze. Slug gripper moves down to impinge on slug with only slight penetration.



3. Keep squeezing. Simultaneously, collet-blade severs insulation without contacting conductor.

4. End of squeeze. As jaws open, moving gripper removes slug. Stationary collet-blade retains stripped lead. No blade scrapes along conductor.

NEW WAY TO STRIP WIRE

MIL 5086-II 600v aircraft electrical wire (or any other wire having comparable finished diameter) can now be stripped consistently with no nicks, no scrapes, no ragged ends, no damage to either conductor or insulation. Ideal has added to its line of the industry's finest precision strippers... the new DUAL-BLADE STRIPMASTER®.

New in concept, smoothly precise, this new hand tool advances the state-of-the-art in mechanical wire stripping to match the quality assurance and reliability standards in present critical programs of wire stripping and terminating.

This new design has a sharp, close-tolerance *stationary blade* to cut the insulation without leaving any ragged strands. Then the slug is slipped off the conductor by the moving gripper without scraping or burnishing the strands. One quick squeeze neatly strips fiberglass insulation from number 10, 12, 14, 16, 18, 20 or 22 wire. Two models available, each with replaceable blades and grippers. *Write for performance specifications.*

IDEAL

IDEAL INDUSTRIES, INC.

5127-I Becker Place, Sycamore, Illinois

Circle 66 on Inquiry Card

World Radio History

5 special industrial reports from DAYTONA BEACH

Florida's newest metropolitan industrial area

GENERAL ELECTRIC

The wholehearted cooperation and assistance we have received from local organizations and individual citizens has helped us respond promptly in support of our nation's Apollo Program.

H. Brainard Fancher
General Manager
Apollo Support Department

ELECTRO TEC CORPORATION
George J. Pandapas
Chairman of the Board

Our growth from a lab in 1953 to a manufacturing plant in 1955 . . . and our immediate plans for expansion . . . certainly reflect our satisfaction and our pleasure in Daytona as a place to work and to live.

FLORIDA PRODUCTION ENGINEERING CO., INC.
Ralph L. Schwarz
President

While our customers are international as well as domestic, we've found that Daytona is attractive to the skilled personnel needed in our business.

DAYTONA MARINE ENGINE CORP.
Charles F. Johnson, Sr.
President

The inland waterway location and the support of an industry-minded community have been vital factors in our growth and in our place here in Daytona . . . as has the wonderful climate.

BELFAB CORPORATION
Edward Z. Najaka
President

The outstanding support given us by this industry-minded community has been a major factor in our growth and our presence in the area, and has made us feel a real part of the community.

AND THIS LIST IS GROWING . . .

FOR THE COMPLETE STORY WRITE TO:

DAYTONA BEACH
JOHN F. KENNEDY AERO SPACE & MISSILE CENTER
CAPE CANAVERAL

ROBERT H. MILES
Committee of 100
Daytona Beach Industrial Area
(Ormond Beach, Daytona Beach, Daytona Beach Shores, South Daytona, Holly Hill, Port Orange)
Box 1309 - Dept. IM-4, Daytona Beach, Fla.
Please send detailed information on the Daytona Beach Industrial Area.

Name _____ Title _____
Company _____
Address _____
City _____ Zone ____ State _____
All inquiries held in strict confidence.

Circle 68 on Inquiry Card

METALIZED MYLAR CAPACITORS

Unique, self-healing units that remain in circuit during voltage surges with little or no loss of electrical properties. Use the M2W's where size and weight are limiting factors and long life and dependability are required. The units utilize metalized Mylar* Dielectric with film wrap and custom formulated epoxy resin end fill. Available in round and flat styles.

*Du Pont Trademark for Polyester Film

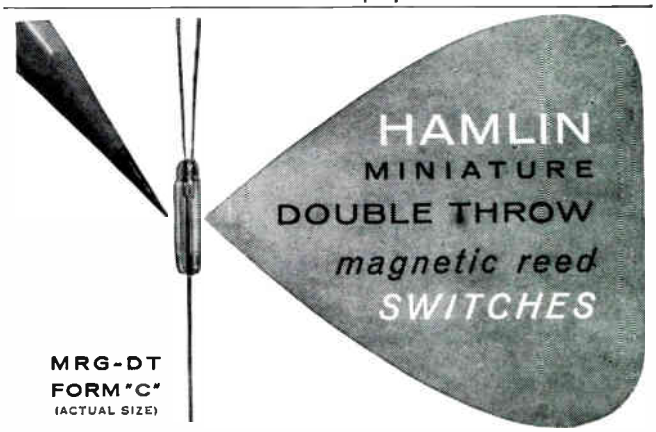
Send for Complete Information

Manufacturers of Hi-Quality Capacitors for the Electronics Industry

Standard CONDENSER CORPORATION

DEPT. EI-9, 3749 N. CLARK STREET, CHICAGO, ILLINOIS

Circle 69 on Inquiry Card



the largest selection ever offered

The use of magnetic reed switches has been increasing by leaps and bounds, and Hamlin engineers have set the pace with the greatest selection. All standard varieties, of course, plus . . .

SEE IT! HEAR IT!

FREE CARD
with magnet and switch

DRVT-1 High Voltages (up to 5000 v)
DRT-5 Heavy Duty (up to 50 v amp.)
DRS-5 Heavy Duty (in-rush to 15 amp.)
DRG-DTH Double Throw (Form "C")
HRC-1 No Bounce (Mercury wetted)
HWDT-1 Mercury Wetted Double Throw
MRG-DT Miniature Form "C"

and many more designed for special requirements . . . YOUR specifications. Send for literature.

HAMLIN INC

DEPT. EI • LAKE AND GROVE STREETS • LAKE MILLS, WISCONSIN

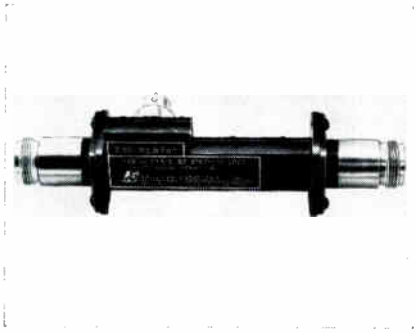
Circle 70 on Inquiry Card

World Radio History

NEW PRODUCTS

MICROWAVE SWITCH

Offers OFF isolation of 50db; exceeds 40db over 4GC to 8GC range.

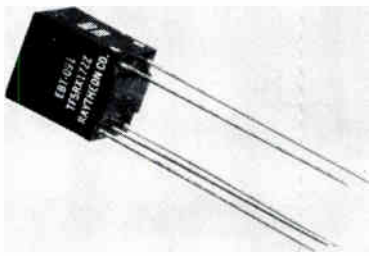


The Model DS 532 solid-state SPST switch handles 1w. It uses conventional Tri-Plate® techniques to meet military requirements and has an operating temp. range of −54°C to +70°C. Insertion loss is 3db max. over complete band. In operation, a 22v. potential applied to the control input turns it off; a potential of approx. +3v. @ 80ma turns it on. Sanders Associates, Inc., Microwave Products Dept., 95 Canal St., Nashua, N. H.

Circle 176 on Inquiry Card

AUDIO TRANSFORMERS

For transistorized-circuit use; impedances from fractions of an Ω and megohms.

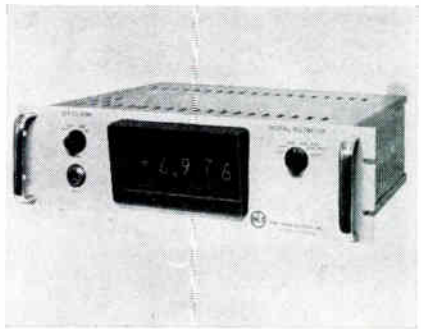


The Autospec Series 7600 transformers meet a wide range of custom electrical uses. Freqs are 100 CPS to 500KC, and power-handling capabilities are from 50mw (300 CPS) to 1.0w. (1.4KC). Audio inductors in the line are rated from 0.2mh to 40h. They meet the requirements of Mil-T-27B. Slip-on shields are available to provide magnetic shielding. Raytheon Co., Magnetics Operation, Foundry Ave., Waltham, Mass.

Circle 177 on Inquiry Card

DIGITAL VOLTMETER

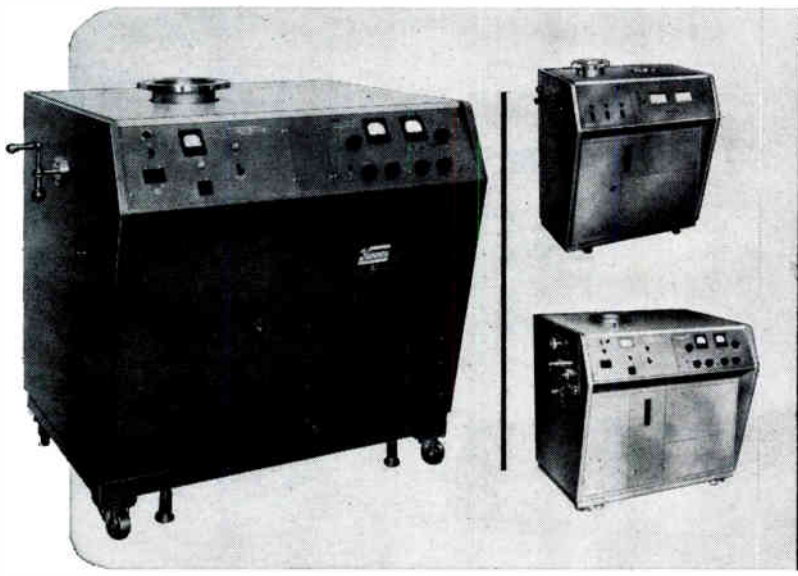
Speed is 20 measurements/sec.; ranges are ±9.999/99.99/999.9v.



The Series 4200 is a high-speed, 4-digit digital voltmeter. Input impedance is 10 megohms; accuracy is ±0.03% of reading +0.02% of full scale. Digital output signals and built-in automatic printer controls permit operating digital recorders. The input leads are isolated from chassis ground, and the instrument rejects ac common-mode noise by at least 100db at 60 CPS. Non-Linear Systems, Inc., P. O. Box 728, Del Mar, Calif.

Circle 178 on Inquiry Card

MOBILITY AND SIMPLICITY OF INSTALLATION ADDS GREATER VERSATILITY TO THESE ALL-PURPOSE PUMPING SYSTEMS



HIGH VACUUM PUMPING FOR ALL APPLICATIONS

Evacuation to 5 x 10^{-7} torr ● Rugged construction guarantees continuous performance under most severe applications ● Available in standard 2, 4 and 6 inch systems ● Kinney liquid nitrogen baffles for maximum conductance with minimum backstreaming ● Compact ● All in one cabinet ● Straight — thru pumping system ● Dependable Kinney Mechanical Pump ● High speed diffusion pump.

KINNEY VACUUM ®

DIVISION THE NEW YORK AIR BRAKE COMPANY
3529 WASHINGTON STREET, BOSTON 30, MASS.

"EVERYTHING IN VACUUM"

Circle 71 on Inquiry Card

World Radio History

There's a Grayhill® Push Button Switch for your specs

- Snap Action—Silent Action
- SPST—DPST—SPDT
- Momentary Contact—Push-Pull—Lighted
- Rating from ¼ Amp. to 10 Amp., 115 VAC Resistive
- Normally Open—Normally Closed
- Life from 50,000 to 1,000,000 operations

Write for Current Engineering Catalog

Grayhill INC.
543 Hillgrove Avenue
La Grange, Illinois 60526
Area Code 312, Phone 354-1040

Circle 72 on Inquiry Card

New Self-Curing Rubber Polymer Potting Compound Only 3¢ cu. in.

DPR® Depolymerized Rubber Offers Excellent Electrical Properties Plus Outstanding Production Advantages

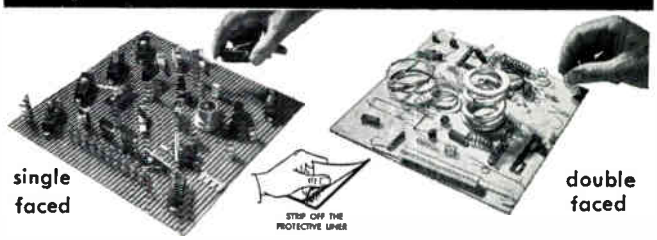
- Pourable
- Cures Without Heat or Sulphur
- No Shrinkage During Cure
- No Exotherm
- Easy to Mix
- No Fumes or Odor
- Cured Hardness Shore A 35-40
- Excellent Shock Absorber
- Temperature Range (–40°C to 80°C)
- 35-45 Minute Pot Life

Price $6.90 gal. FOB Plant (12.5 lbs., 231 cu. in. per gal.)
4 Gallon Minimum Order

DPR INCORPORATED A SUBSIDIARY OF H. V. HARDMAN CO., INC.
583 Cortlandt St., Belleville, N. J. 07109

Circle 73 on Inquiry Card

Pressure Sensitive Adhesive Panels ...for shipping, storing and handling of parts & products



single faced — double faced

PRES-PAK pressure-sensitive adhesive coated board provides a simple solution to a thousand problems in production, shipping and inter-plant transport. Parts adhere firmly during transport but are removed easily for use. Ideal for electronic components, wire-forms, springs, fragile abrasives, etc. Available in single and double faced corrugated and chip board with light, medium and heavy adhesive coatings.

PRES-PAK is available in square panels or die-cut to custom shapes and designs.

Problems are being solved daily with this unique, new method. Let us assist you with yours. Send us the details for a prompt reply and solution.

DEALER INQUIRIES INVITED, ALSO!

PRES-ON PRODUCTS CO.
Factory Road KI 3-9466 Addison, Ill.

Circle 74 on Inquiry Card

World Radio History

HOW PRECISION CAN LOWER YOUR BOBBIN COSTS!

From Prototype Through Production

For engineering and prototype quantities: Our fabrication facilities enable us to supply virtually any type bobbin desired. Over 4,000 tools accumulated over 25 years permit the production of small quantities at no tooling cost or, in some cases, a small revision charge. Materials can be furnished to meet practically any electrical and temperature requirement.

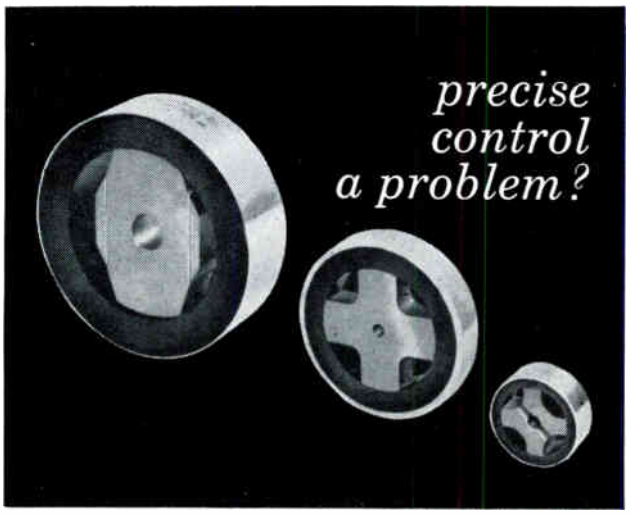
For production quantities when mold costs can be absorbed: The transition can be made economically to molded parts. Our fully automatic single cavity system provides parts at low mold cost and piece prices comparable to multi-cavity operation. Bobbins can be furnished in all thermo-plastics, including glass filled and asbestos filled materials for elevated temperatures.

Request bulletins. Send or phone specifications for quote.

BUCKEYE BOBBIN DIVISION
PRECISION PAPER TUBE COMPANY

12200 SPRECHER AVE., CLEVELAND 35, OHIO
TELEPHONE: ORchard 1-5200

Circle 75 on Inquiry Card



It won't be if you use an Aeroflex "brushless" DC torque motor. The only torquer designed for limited angular excursion. Successfully used on:

- Mid-course motor for Mariner and Ranger
- Satellites
- Horizon sensors for Saturn V
- Throttle control for automated trains
- Aero-space stabilized platforms
- Antenna and tracking mount drives

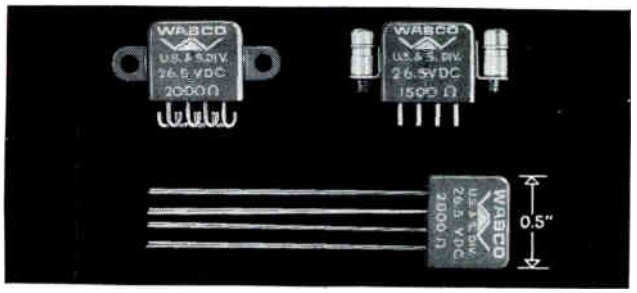
For free specification charts on torquer performance, write to Dept.RB-96.

AEROFLEX

AEROFLEX LABORATORIES
INCORPORATED
South Service Road, Plainview, L. I., New York
(516) MYrtle 4-6700

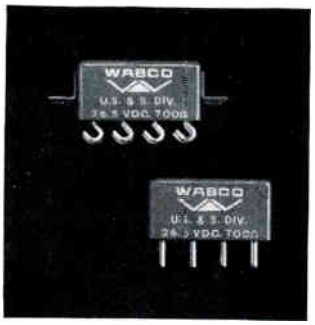
Circle 76 on Inquiry Card

MEET THE NEW WABCO RELAYS



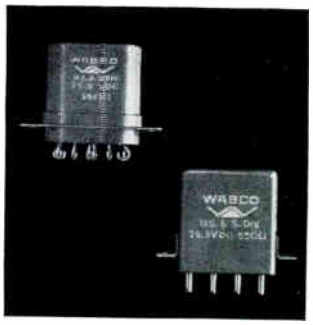
MODEL 901—⅛-size crystal case DPDT relays

Meets or exceeds MIL-R5757D. Printed circuit board, brackets, and plug-in mountings available. 0.1″ grid spaced terminals. Size: .500″L x .230″W x .430″H. Weight: 0.15 ounce. Coil Rating: 6, 12, 26.5, 48, 76 VDC (others available). Contact rated load: low level dry circuit to 1.0 amp resistive, 26.5 VDC. Terminals: 1½″, solder hooks, or plug-in. Vibration: 0.1″ D.A. or 20G peak, 10 to 2000 cps. Shock: 50G for 11 milliseconds. Temperature: —65°C to 125°C. Write for Bulletin 1077-A. Also available as SPDT—Model 900, write for Bulletin 1076.



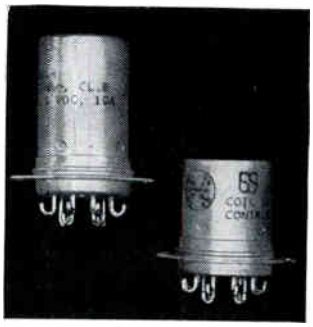
MODEL 902
½-size crystal case relays

Meets or exceeds MIL-R5757/9. Size: .80″ L x .40″ H x .40″ W. Write for Bulletin 1073.



MODEL 903 "S"-type header
MODEL 904 0.2″ grid header
crystal case relays

Meets or exceeds MIL-R5757/10. Size: .80″ H x .80″ L x .40″ W. Write for Bulletin 1078.



MODEL H
4PDT 10-ampere relays

Meets or exceeds MIL-R5757D. Size: 1⅛″D x 1½″ H (AC and sensitive versions available in 2″ height). Write for Bulletin 1069.

MODEL J
6PDT 2-ampere relays

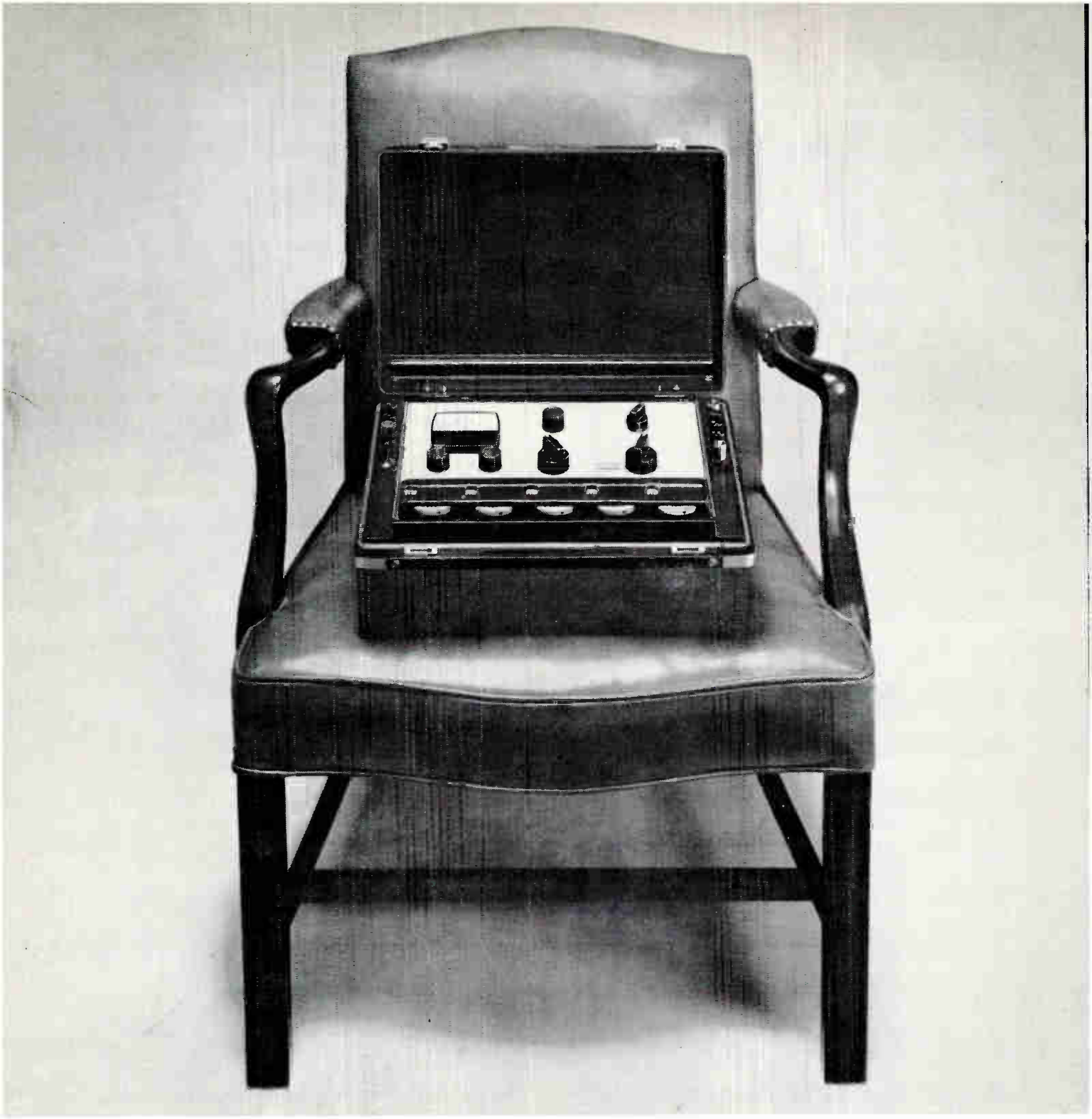
Meets or exceeds MIL-R5757/1. Size: 1⅛″D x 1½″ H (AC sensitive versions available in 2″ height). Write for Bulletin 1075.

These reliable relays are constructed of precision-made parts to exacting tolerances and assembled under "White Room Conditions" for uniformity of production and to provide consistent, dependable performance. They are available from stock in standard mountings and coil ratings. For technical information, call or write WABCO Aerospace Products. Telephone 242-5000, Area Code 412. TWX 412-642-4097, TELEX 086748.

WABCO UNION SWITCH & SIGNAL DIVISION
PITTSBURGH, PA. 15218/Westinghouse Air Brake Company

Circle 77 on Inquiry Card

World Radio History



"I solemnly swear to tell the truth ± .003%"

Our new Portametric Voltmeter testifies to an accuracy several times better than most laboratory potentiometers. This means it can easily double as a voltage calibration system for laboratory potentiometers, digital and differential voltmeters. It also serves as a precision voltage source.

Everything you need to start making measurements is included: five-dial potentiometer, voltbox, zener-regulated working voltage source, a portable reference standard cell and a solid-state null detector of high sensitivity. They're all conveniently built into the portable case, and you buy the works for one low price — $895.

Up to now, there has been nothing on the market at this price with this kind of accuracy. We offer it as witness to ESI measurement capabilities and invite you to be the judge. *ESI, 13900 NW Science Park Drive, Portland, Oregon (97229).*

Model 330 Portametric Voltmeter

Voltmeter Ranges: 5—120 millivolts to 1200 volts.
Potentiometer Accuracy: ± 10 ppm of reading ± 1 ppm full scale on each range.
Voltbox Accuracy: ± 10 ppm.
Standard Cell Accuracy: ± 10 ppm.
Input Impedance: Infinite at null on ranges 1, 2 and 3. 10 megohms on ranges 4 and 5.
Battery Life: Approximately 1000 hours.
Null Detector: High-gain solid-state guarded detector; more than 5 microvolts dc sensitivity; input impedance: about 1 megohm.

esi® **Electro Scientific Industries**

Circle 78 on Inquiry Card

World Radio History

FREE! Use These Cards for:

- Catalogs, Bulletins, Literature • Design features of advertised products
- Information about new Products • New Tech Data for Engineers

FIRST CLASS
PERMIT NO. 36
PHILA., PA.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed in U.S.A.

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES

P. O. Box 9801
Philadelphia, Pa. 19140

FIRST CLASS
PERMIT NO. 36
PHILA., PA.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

POSTAGE WILL BE PAID BY

ELECTRONIC INDUSTRIES

Chilton Company

Chestnut & 56th Sts.

Philadelphia, Pa. 19139

Att: Circulation Dept.

World Radio History

FREE! Use These Cards for:

- Catalogs, Bulletins, Literature • Design features of advertised products
- Information about new Products • New Tech Data for Engineers

YOUR NAME ..... **TITLE** .....

FIRM ..... **Mail Stop or Div./Dept.** .....

FIRM ADDRESS .....

CITY OR TOWN ..... **ZONE** ..... **STATE** .....

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260
261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320
321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340
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

Please send me further information on the items I have circled above.
Postcard valid 8 weeks only. After that use own letterhead describing item wanted.

1-A EI-229 SEPTEMBER 1964

NEW Change of Address

Company_____

Mail Stop/or Dept., Div._____

Street_____

City_____ State_____ Zip_____

OLD PASTE WRAPPER IMPRINT OR WRITE COMPLETE OLD ADDRESS

ELECTRONIC INDUSTRIES

Source Date | Co. Code | File No. | Function Industry | Title Unit

1. Do you wish to continue receiving ELECTRONIC INDUSTRIES? Yes___ No___

Signature_____ Title_____

2. Check—ONE—box for your PRIME FUNCTION

A		Corporate Management	Pres., V.P.'s, Chiefs, Directors, Dept. Heads, Mgrs. & Asst.
B		Engineering Management	
C		Manufacturing Management	
D		Circuits	DESIGN ENGINEERING
E		Components	
F		Equipment	
G		Systems	
H		Research & Development Engineering	
J		Application	
K		Evaluation	
M		Mechanical	
N		Quality Control	
P		Production	
R		Reliability	
S		Standard	
T		Test	
V		Value	
W		Purchasing	
X		Sales	
Y		Co. Copies & Libraries	
Z		All Others	

3. Check—ONE—box for your plant's PRIME nature of business

MANUFACTURING INDUSTRIES

- ☐ (01) Computers, Data Processing & Peripheral Equipment Mfr.
- ☐ (02) Communication Systems & Equipment Mfr.
- ☐ (03) Consumer Electronic Equipment Mfr.
- ☐ (04) Industrial Control Systems & Equipment Mfr.
- ☐ (05) Navigation & Guidance System Mfr.
- ☐ (06) Test Measurement & Instrumentation Mfr.
- ☐ (07) Aircraft, Ground Support, Missile, Space Vehicle & Undersea Access & Equipment Mfr., not covered in other product classifications
- ☐ (08) Component Mfr.
- ☐ (09) Sub-System Assembly Mfr. (Modules, Assembled Circuits)
- ☐ (10) Materials & Hardware Mfr.
- ☐ (11) Industrial Co. Using or Incorporating Any Electronic Equipment In Their Manufacturing, Research or Development Activities. (Other than Electronic Co.)

NON MANUFACTURING INDUSTRIES

- ☐ (12) Commercial Users of Electronic Equipment
- ☐ (13) Independent Research, Test & Design Laboratories & Consultants (Not Part of a Manufacturing Company)
- ☐ (14) Government Agencies & Military Agencies
- ☐ (15) Distributors, Mfr. Representatives
- ☐ (16) Education & Libraries
- ☐ Other (explain) _____

4. This Address is (check most applicable)

☐ Mfg. Plant (*) ☐ Mfr's R&D Lab. (&) ☐ Other (e' plain) _____

If address shown is your home, where is your company located? City_____ State_____

World Radio History

NEW *Subscription Order*

Company_____

Mail Stop/or
Dept., Div._____

Name_____

Company
Address_____

City_____ State_____ Zip_____

ELECTRONIC INDUSTRIES

Source / Date	
Co. Code	
File No.	
Function / Industry	–
Title / Unit	–

1. I wish to receive ELECTRONIC INDUSTRIES

Signature_____ Title_____

2. Check—ONE—box for your PRIME FUNCTION

Pres., V.P.'s, Chiefs, Directors, Dept. Heads, Mgrs. & Asst.			DESIGN ENGINEERING																			
Corporate Management	Engineering Management	Manufacturing Management	Circuits	Components	Equipment	Systems	Research & Development Engineering	Application	Evaluation	Mechanical	Quality Control	Production	Reliability	Standard	Test	Value	Purchasing	Sales	Co. Copies & Libraries	All Others
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
A	B	C	D	E	F	G	H	J	K	M	N	P	R	S	T	V	W	X	Y	Z

3. Check—ONE—box for your plant's PRIME nature of business

MANUFACTURING INDUSTRIES

- ☐ (01) Computers, Data Processing & Peripheral Equipment Mfr.
- ☐ (02) Communication Systems & Equipment Mfr.
- ☐ (03) Consumer Electronic Equipment Mfr.
- ☐ (04) Industrial Control Systems & Equipment Mfr.
- ☐ (05) Navigation & Guidance System Mfr.
- ☐ (06) Test Measurement & Instrumentation Mfr.
- ☐ (07) Aircraft, Ground Support, Missile, Space Vehicle & Undersea Access & Equipment Mfr. not covered in other product classifications
- ☐ (08) Component Mfr.
- ☐ (09) Sub-System Assembly Mfr. (Modules, Assembled Circuits)
- ☐ (10) Materials & Hardware Mfr.
- ☐ (11) Industrial Co. Using or Incorporating Any Electronic Equipment In Their Manufacturing, Research or Development Activities. (Other than Electronic Co.)

NON MANUFACTURING INDUSTRIES

- ☐ (12) Commercial Users of Electronic Equipment
- ☐ (13) Independent Research, Test & Design Laboratories & Consultants (Not Part of a Manufacturing Company)
- ☐ (14) Government Agencies & Military Agencies
- ☐ (15) Distributors, Mfr. Representatives
- ☐ (16) Education & Libraries
- ☐ Other (explain) _____

4. This Address is (check most applicable)

☐ Mfg. Plant (*) ☐ Mfr's R&D Lab. (&) ☐ Other (explain) _____

If address shown is your home, where is your company located? City_____ State_____

Please send me further information on the items I have circled above.
Postcard valid 8 weeks only. After that use own letterhead describing item wanted.

1-B EI-229 SEPTEMBER 1964

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	**20**
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	**40**
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	**60**
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	**80**
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	**100**
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	**120**
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	**140**
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	**160**
161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	**180**
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	**200**
201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	**220**
221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	**240**
241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	**260**
261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	**280**
281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	**300**
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	**320**
321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	**340**
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**

YOUR NAME . . . . . TITLE . . . . .

FIRM . . . . . Mail Stop or Div./Dept. . . . . .

FIRM ADDRESS . . . . . .

CITY OR TOWN . . . . . ZONE . . . . . STATE . . . . . .

FREE! Use These Cards for:

- Catalogs, Bulletins, Literature • Design features of advertised products
- Information about new Products • New Tech Data for Engineers

World Radio History

FREE! Use These Cards for:

- Catalogs, Bulletins, Literature
- Design features of advertised products
- Information about new Products
- New Tech Data for Engineers

FIRST CLASS
PERMIT NO. 36
PHILA., PA.

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed in U.S.A.

POSTAGE WILL BE PAID BY
ELECTRONIC INDUSTRIES
P. O. Box 9801
Philadelphia, Pa. 19140

FIRST CLASS
PERMIT NO. 36
PHILA., PA.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN UNITED STATES

POSTAGE WILL BE PAID BY
ELECTRONIC INDUSTRIES
Chilton Company
Chestnut & 56th Sts.
Philadelphia, Pa. 19139

Att: Circulation Dept.

World Radio History

If you haven't found the exact gold plating process you want

Here are 3 new Sel-Rex bottle caps to look under.

The FIRST heavy duty electroless gold plating process.

(*Not* to be confused with immersion methods which are often called "electroless".) Stable, long-lasting. Easily replenishable to yield virtually constant plating rate. Maintains uniform coverage to .001" or higher with excellent adhesion. Write for bulletin on LECTROLESS® AU.

A bright 75-85% gold alloy acid process, with a DPH value of 450.

Excellent solderability and etch resistance, exceptional anti-galling characteristics, superior resistance to wear and corrosion. For circuit boards, connectors, switches, etc. Write for bulletin on AUTRONEX® W.

A low cost, hard, mirror bright 70-80% gold alloy alkaline process.

Corrosion and tarnish resistance characteristics comparable in many respects to high karat deposits. Applied cost is substantially lower than that for any other gold deposit. Especially attractive for heavy plating. Write for bulletin on ALAUTRONEX™ 18.

Write to Dept. EI-9, **SEL-REX CORPORATION, Nutley, N. J. 07110**

Sel-Rex®

the company that originated the bright gold and acid gold processes

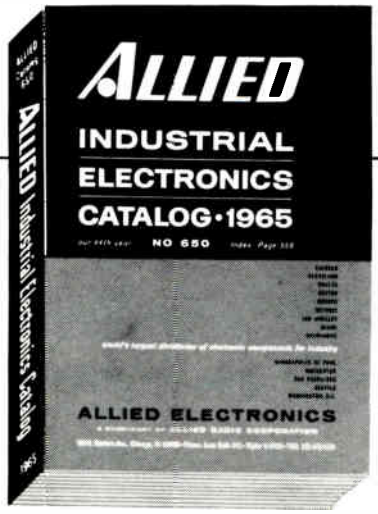
World Radio History

exclusively for industry

free

ask for your *1965*

ALLIED INDUSTRIAL CATALOG NO. 650



576 PAGES • COMPLETE INDUSTRIAL ELECTRONICS SUPPLY CATALOG FOR THE SPECIAL USE OF PURCHASING AGENTS AND ENGINEERS

• World's Largest Stocks of Electronic Components
• Same Day Shipment • Factory OEM Prices

For FREE copy, check reader service card or write direct

ALLIED ELECTRONICS

subsidiary of ALLIED RADIO CORPORATION

100 N. Western Ave., Dept. 77-J, Chicago, Illinois 60680

P&B RELAYS

WIDEST SELECTION • SAME-DAY SHIPMENT

See your Allied Catalog for Potter & Brumfield Relays: General Purpose, Special Purpose, Power, High Performance, Mercury Wetted Contact, Telephone types—available from stock. Circle reader service card for your Allied Catalog.

Circle 80 on Inquiry Card

Micro-Modular & Sub-miniature

PERMACOR®

Electronic Powdered IRON CORES

Conventional shapes and sizes available.

Write for Literature Today!

PERMACOR®

A Division of Radio Cores, Inc.

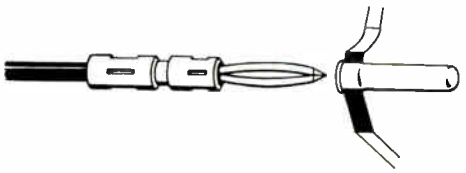
9540 Tulley Ave., Oak Lawn, Ill. • Phone: 312-GArden 2-3353

Circle 81 on Inquiry Card

NEW PRODUCTS

MINIATURE CONNECTORS

Construction allows insertion pressure to vary with the number of contacts.



The Bow-Pin series of ultraminiature connectors have contacts on 0.050 and 0.075 in. centers. The Bow-Pin contact uses a bowed-spring principle. Here, 2 wires are positioned with the flat portions of the cross-section facing. The wires are bowed slightly and fastened to the contact base. The front ends are not attached, permitting flexing action. This allows the wires to straighten against each other when inserted into a tube having a smaller ID than the widest dimension of the bow. Cinch Mfg. Co., 1026 S. Homan Ave., Chicago, Ill.

Circle 179 on Inquiry Card

CRT RECORDER

Records at spot image speeds to 200,000 in./sec.

Model OR-285 combines magnified images from a high-resolution CRT and up to 8 conventional galvanometers on to a single, moving 12-in. permanent film or paper record. Resolution is 500 line pairs on 10 in. of recording media. The CRT recorder is linear, flat to 20KC in the swept axis, and intensity modulated via a 4MC video amplifier, making it useful to 30 ips paper speed. Interstate Electronics Corp., subs. of Interstate Engineering Corp., 707 E. Vermont Ave., Anaheim, Calif.

Circle 180 on Inquiry Card

PARAMETRIC AMPLIFIER

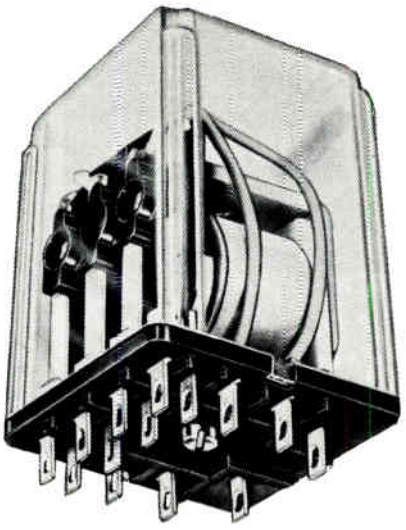
Tunable amplifier for retrofit into existing L-band radar systems.

This amplifier operates in the 1250-1350MC range. It can be installed within an existing equipment cabinet, whereas the power supply control unit may be located at any convenient remote point. It has a noise figure of 1.5db when followed by a second stage of 10db or less, and can be tuned over a range of about 20MC by varying the varactor bias voltage. For frequency changes in excess of 20MC, adjustment of the pump freq. is required also. Airborne Instruments Lab., div. of Cutler-Hammer, Inc., Deer Park, L. I., N. Y.

Circle 181 on Inquiry Card

World Radio History

new developments in "GPR" relays



The only available 4-pole unit in this type of relay

For the first time, you can get the *extra circuit-handling* capability of a 4PDT combination in a good quality, economical, compact relay of this type. This is made possible by the unique design of Ohmite GPR relays which locates *all terminals* (including coil terminal) on *one panel*. Terminal panel meets UL spacing requirements for 150 volts.

The 4PDT model is currently *stocked for immediate delivery* as open or enclosed units with 5-amp or 10-amp contacts—regular models, plate circuit types, and for thyratron (2050, 2D21) plate circuits. Coil operating voltages range from 6 to 230 VAC and 6 to 110 VDC. (BULLETIN 707)

SOCKETS UP TO 4-POLE MEET UL TERMINAL SPACING REQUIREMENTS FOR 150 VOLTS.

Low cost, plug-in sockets

Here's the welcome convenience of a plug-in connection for the Ohmite line of GPR relays. SOGPR sockets accommodate all standard 4PDT models, and UL approved models up to 3PDT—both the open and enclosed types.

Firm, snug mounting is assured even under conditions of vibration and shock by means of a hold-down spring, which can be used at your option, or as the application demands.

The solder terminals on the new sockets are the Ohmite multi-use type, and will accept AMP110 quick-connect (push-on) connectors. SOGPR sockets are carried in stock for *immediate delivery*.

(BULLETINS 706 and 707)

OHMITE "GPR" RELAYS ARE LOADED WITH PROBLEM-SOLVING FEATURES

CHOICE of below-chassis or above-chassis connecting in plastic enclosures.

MULTI-USE terminals allow soldering, insertion in printed circuit board, and use of AMP Style 110 push-on terminals.

ALL TERMINALS on *one* panel . . . permits insertion in printed circuit board.

OCTAL PLUG relays up to DPDT have recessed pin bases . . . meet UL spacing requirements to 150 V.

ALL ENCLOSED relays mount solidly on base . . . *not* on covers.

INTEGRAL plug-in base up to DPDT avoids wiring between contact terminals and pins.

Call Your Distributor or Write for Complete Relay Catalog 700

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

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

World Radio History

Is Your Knowledge of Computer Fundamentals and

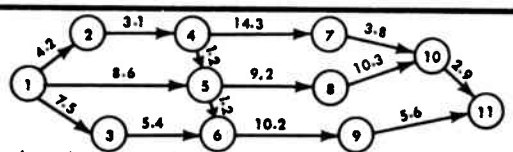
TEST YOUR SKILLS
IN THESE GROWTH AREAS
OF YOUR INDUSTRY

Engineers and technicians at General Electric, North American Aviation, ITT, General Dynamics, Raytheon, Philco, Douglas Aircraft, Continental Device, Automatic Electric, and other leading companies have selected 5 initial subjects in these areas for their own personal development.

Test **your** knowledge of these fundamental subjects. Here are some sample questions from comprehensive examinations being used in the electronics industry to measure performance in these areas. Try them yourself.

BASIC TRANSISTOR CIRCUITS

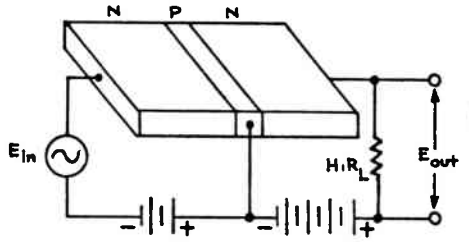
PERT



12. Examine the network you have just constructed.
   (a) Identify the critical path by giving the sequence of events along the path: _____
   (b) Give the T_E which you calculated for the ending event of the network. _____ weeks
   (c) If, for this project, the T_L for the network ending event is set equal to the T_E, what is the slack for event 7? _____ weeks
   (d) It is now reported that activity 6-9 cannot be completed in less than 11.8 weeks. Will it still be possible to meet T_L? ☐ yes ☐ no
   (e) If the changes mentioned in (d) above would make it impossible to plan completion of the project by the time the allotted span has run out, what can he do to replan so that he does meet the schedule (EXPLAIN)?

COUNTING SYSTEMS AND BINARY ARITHMETIC

INTRODUCTION TO TRANSISTORS



29.
   (a) The NPN transistor circuit illustrated above operates as a(n) _____
   (b) With reference to the circuit shown above, MATCH the items below on the left with those on the right by placing one letter in each blank:

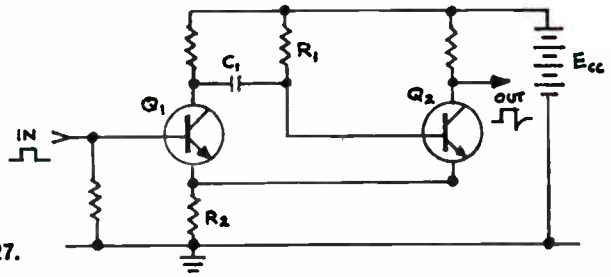
A. base-collector junction	1.___high impedance
B. emitter-base junction	2.___input impedance
	3.___low impedance
	4.___output impedance

BOOLEAN ALGEBRA
(in development)

A Joint Service of ELECTRONIC INDUSTRIES MAGAZINE
56th and Chestnut Streets
Philadelphia, Pa.

World Radio History

Project Management Techniques Competitive?



27.

(a) The schematic diagram above shows an emitter-coupled one-shot _____.

(b) In the stable state Q_1 is ☐ on ☐ off and Q_2 is ☐ on ☐ off.

(c) The positive pulse turns on Q_1 which in turn ☐ cuts off Q_2 ☐ turns on Q_2.

(d) When C_1 discharges, Q_2 is ☐ cut off ☐ turned on.

(e) When Q_2 conducts, drawing current through R_2, Q_1 becomes _____ biased.

3. PERFORM THE FOLLOWING ARITHMETIC CONVERSIONS.

(a) CONVERT the decimal numbers 85 and 35 into binary equivalents and

(b) ADD their binary equivalents, then

(c) CONVERT the sum back to decimal

(d) CONVERT the decimal number 26 into its binary equivalent and

(e) SUBTRACT it from the binary sum you found in (b)

(f) CONVERT the result back to decimal

SHOW the Karnaugh map of the function $AB\bar{D} + A\bar{C}\bar{D} +$, $B\bar{C}\bar{D} + \bar{A}\bar{B} + \bar{A}CD$ by SHADING the appropriate boxes in the diagram below:

AB / CD	00	01	11	10
00				
01				
11				
10				

The Karnaugh map shows that the minimum inputs required for this function are _____.

HOW CAN YOU UPGRADE YOUR KNOWLEDGE OF THESE SUBJECTS?

Thousands of engineers and technicians are turning to PROGRAMMED INSTRUCTION. It's "an ideal way to train engineers in technical subjects. Through its use men learn 10% to 25% more in half the time," according to Russell S. Pease, Engineering Department, E. I. du Pont de Nemours.

These 5 subjects are now available as the initial courses in a programmed instruction series. With these self-instructional programs, you can master an entire subject in a day's time—and score 90% on a comprehensive final exam.

For example, engineering members of the American Materials Handling Society developed the following data using the PERT self-instructional program at home in their spare time.

Trainee	1	2	3	4	5	6	7	8	Average
Job Title	Foreman	Ops. Mgr.	Proj. Eng.	Supervisor	Supervisor	Pers. Mgr.	Chief Eng.	Traffic Mgr.	
Education	H.S.	B.S.	M.S.	H.S.	H.S.	B.A.	B.S.	B.S.	
Time (hrs.)	11.3	10.5	9.4	13.3	19.0	13.8	11.3	9.5	12.2 hrs.
Age (yrs.)	36	22	44	48	52	47	47	50	43 yrs.
Score (%)	94	97	97	94	92	87	80	79	90.1%

To rate your own performance and skill needs in these subjects:

1) Send for free copies of the complete final exams for these programs.
2) Take each exam.
3) If you feel you could profit from a thorough knowledge of the subject, send for the self-instructional program.

Please send me the following programs and exams:

TITLE	PRICE	SEND FREE EXAM	SEND PROGRAM
PERT	$12.50	☐	☐
Introduction to Transistors	9.50	☐	☐
Transistor Circuits	9.50	☐	☐
Counting Systems and Binary Arithmetic	7.50	☐	☐
Applied Electricity	12.50	☐	☐

☐ My check or company purchase order is enclosed.
☐ Bill me or my company directly.

Name _____
Title _____
Company _____
Address _____
City _____ State _____

Clip and send this coupon to:
Basic Systems, Inc., 2900 Broadway, New York, N. Y.

and **BASIC SYSTEMS, INC.**
2900 Broadway
New York, N.Y.

Circle 83 on Inquiry Card

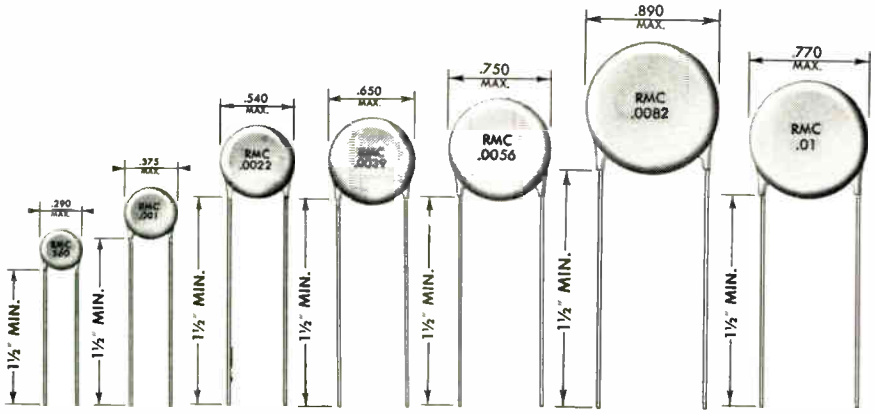
World Radio History

RMC

HIGH STABILITY, TYPE JE

DISCAPS

are Practically Immune to Severe Temperature Change



150	330	680	.0012	.0027	.0047	.0068	.01*
180	390	820	.0015	.0033	.0056	.0082	
220	470	.001	.0018	.0039			
270	560		.0022				

*Dual Disc construction—long leads only.
Disc sizes under ½" diameter have lead spacing of .250".
Disc ½" diameter and over have .375" spacing.

Specifications

CAPACITANCE: Within tolerance @ 1KC and 25°C.

CAPACITANCE TOLERANCES: +-10%, +-20% or +80 - 20%

WORKING VOLTAGE: 500 VDC

POWER FACTOR: 2.0% @ 1KC

INSULATION RESISTANCE: Greater than 7500 Megohms @ 500 VDC

TEMPERATURE COEFFICIENT: Z5E, Y5E

FLASH TEST: 1250 VDC for one second

LIFE TEST: Per EIA RS-198 Class II

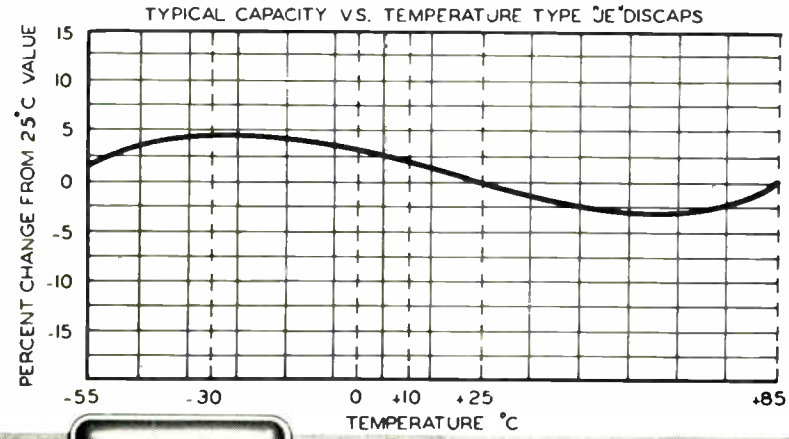
POWER FACTOR AFTER HUMIDITY: 3.0% @ 1KC

INSULATION RESISTANCE AFTER HUMIDITY: Greater than 1000 Megohms @ 500 VDC

BODY INSULATION: Durez phenolic -- vacuum wax impregnated

LEAD STYLES AVAILABLE: Long lead - #22 tinned copper -, fin-lock, kinked lead plug-in and pin type plug-in

RMC Type JE Discaps exhibit only ± 4.7% capacitance change over the extended —30° to + 85°C temperature range. These capacitors are especially suited for use in mobile communication and like equipment. Typical usage in R-C response shaping networks and feedback loops, in addition to conventional applications, is indicated.



DISCAP CERAMIC CAPACITORS

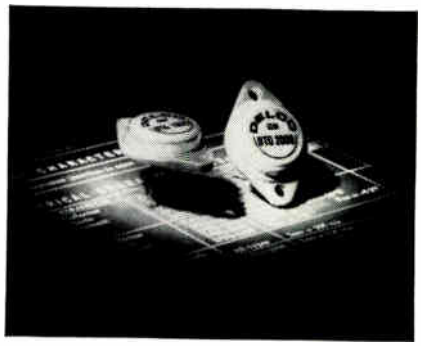
RMC

RADIO MATERIALS COMPANY
A DIVISION OF P. R. MALLORY & CO., INC.
GENERAL OFFICE: 4242 W. Bryn Mawr Ave., Chicago 46, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

NEW PRODUCTS

HIGH-POWER TRANSISTORS

Current ratings of 15 and 25a. with sustaining voltage to 325v.



The DTG 1000 and 2000 series are high-power germanium devices. The 1000 series is rated at 15a. and are well suited for video horizontal and vertical deflection circuits. The 2000 series have a 25a. collector current and sustaining voltages from 30 to 120v. Delco Radio Div., General Motors Corp., Kokomo, Ind.

Circle 190 on Inquiry Card

PULSE GENERATOR

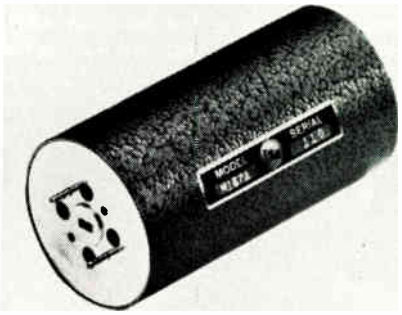
Full pulse delay of 0 to 10K μsec.; full pulse width of 0.10 to 10K μsec.

The transistorized B-16 has repetition rate of 20 CPS to 20MC. Other specs. include: output amplitude of 0 to 10v., peak, into a 50Ω resistive load; rise and fall time variable from less than 5nsec. to 200nsec.; positive or negative polarity. Rutherford Electronics Co., P. O. Box 768, El Segundo, Calif.

Circle 191 on Inquiry Card

WAVE ISOLATOR

Offers min. isolation of 20db with a max. insertion loss of 1.5db.



Model M157A is broadband millimeter wave ferrite isolator. Input VSWR is 1.25 max.; power is 100mw max. Freq. range is 50—65GC. The unit uses RG-98/U type waveguide and is fitted with UG-385/U flanges. Its insertion length is only 2¾ in. FXR, 33 E. Franklin St., Danbury, Conn.

Circle 192 on Inquiry Card

World Radio History

Our new Mother...all-silicon solid state

We're normally a hard-nosed, unsentimental bunch at CMC, dedicated to giving the other two major makers of electronic counters (Hewlett-Packard and Beckman) a run for their money. So you wouldn't think we'd have time for motherhood or advancing the counter art. **But,** we've scored on all three with our new 600-Series. (1) It's the first all-silicon solid state counter. You can't get one anywhere else. (2) We're the first of the big three to use the advanced "mother board" technique. So we've cut size, weight, and components while increasing reliability and ease-of-maintenance. (3) Our 600-Series can be ordered to operate perfectly in temperatures from −30° to +75°C. (Other folks we know strain to claim −25° to +65° C.) You also get a frequency readout from 2 cps to 1.2 Mc. That's four times faster than any competitive counter at the price. All this, and a price that's competitive with ordinary germanium counters. **Something free!** We give a glorious Crusading Engineers medal to engineers who have the courage to compare **everyone's** performance specs before buying a counter. Get yours by writing for our technical catalog. It's free, too. And your Mother will be so proud of your medal.

CMC

12974 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.

World Radio History

SPERRY

ASSURED RELIABILITY
DIFFERENTIAL AMPLIFIER TRANSISTORS

2N2639AR – 2N2644AR
2N2720AR – 2N2722AR
2N2913AR – 2N2920AR

AR — denotes Assured Reliability

Send for Sales Rep.
Circle 86 on Inquiry Card

Differential Amplifier Transistor Specification Sheet
Circle 87 on Inquiry Card

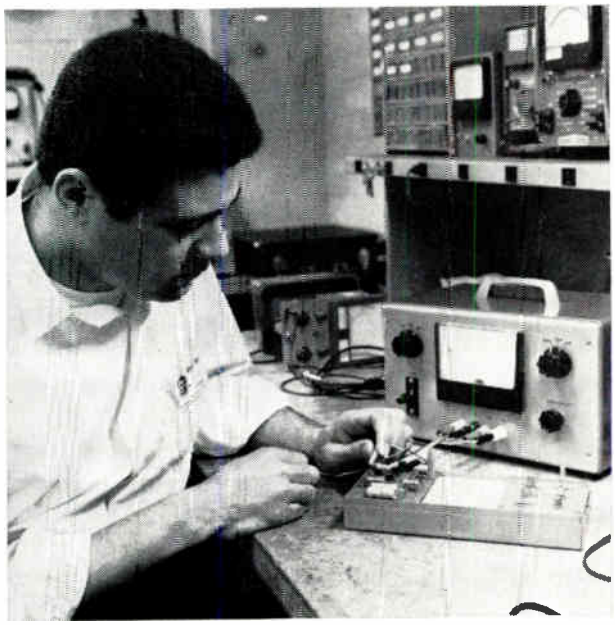
NOW – Differential Amplifier Transistors with Assured Reliability. Here's something meaningful to industrial and military designers – ASSURED RELIABILITY. This Sperry reliability program includes continuous monitored production, 168 hours power burn-in, and Sperry's Product Reliability Evaluation Program. P.R.E.P. evaluates the environmental and operational capabilities of the devices through continuous sampling and comparison to achieve complete uniformity. The result – exceptional parameter stability for extended use, close temperature tracking, and extremely high gain. ☐ ASSURED RELIABILITY is particularly important in small signal applications which require low drift ($1\mu V/°C$) as in d.c. and operational amplifier designs. Sperry's line of low drift differential amplifier transistors from $1\mu A$ to 10 milliamps reduces design complications and eliminates stages. Learn more about this Sperry extra and how to get Assured devices at no extra cost – send for your copy of Bulletin AR-3, "Specification for Assured Reliability Differential Transistors". ☐ **SPERRY SEMICONDUCTOR, Norwalk, Connecticut 06852**
SPERRY EUROPE CONTINENTAL, 7 Avenue de l'Opera, Paris 1, France

SPERRY
DIVISION OF SPERRY RAND CORPORATION

World Radio History

TRANSISTOR CHECK

In-circuit transistor leakage current test can now be performed by a device developed by ITT Research Institute. The battery-powered, portable device measures current to 1μa.



An attitude sensing system, which keeps an infrared eye on the earth, has been delivered by Barnes Engineering for use on the Meteroid Detection Satellite. The unit, which has no moving parts, consists of 6 sensing heads that operate continuously for 1 year.

The calibration of a VTVM consists of three steps: tracking linearity error measurement over entire scale; range error measurement for every range position; and freq. response and error measurement over specified freq. and voltage ranges. The procedures for these steps are offered by Ballantine Laboratories, Boonton, N. J.

Liquid levels in sealed containers can be measured by ultrasonic means with equipment developed by Electronic Applications Ltd. London, England. Readings, which are shown on a 3-digit display panel, are accurate to 0.2 in.

A tube tester with a built-in conscience has been developed to protect costly high-frequency tubes. The tester, a product of the Votator Div. of Chemetron Corp., short-circuits its 30kv power supply if the tubes under test are in danger of being damaged. A special device prevents power surges from bothering the neighbors' electricity by clearing the fault. The tester was developed by the Louisville, Ky. firm for a Connecticut electronics plant at a cost of $400,000.

Measurements of humidity by microwave refractometry have been made at millimeter spacings by NBS. Point sampling is accomplished by drawing the sample into a fine probe and through the refractometer cavity. Accuracy of better than 0.2 g/m³ in absolute humidity can be obtained.

A highly accurate inertial calibration instrument, Model 235 Two-Axis Air-Bearing Test Table, evaluates present guidance systems and also other test equipment and components under development. A product of American Optical, the table tilt axis is orthogonal to the table axis within 1 sec. of arc.

ASTM Committee D-9 on Electrical Insulating Materials have formed Subcomittee IV on Measurement of Dielectric Properties of Materials in Simulated Space Environments and Cryogenic Conditions. Dielectric properties to be measured include strength, dielectric constant, dissipation factor, volume resistivity, and surface resistivity.

An accurate, secondary-standard source of voltage, current, and resistance has been developed which automatically computes the percentage error of an instrument under test. The Model MC-10, developed by Abbey Electronics, is a Universal Calibrator which presents this figure on a direct-reading scale.

RIGHT TIME FOR SWISS

Agreement in time has been established between the Naval Observatory in Washington and the Observatoire de Neuchatel in Switzerland by using atomic clocks. Two Hewlett-Packard clocks were set at one observatory and then flown to the other. Here the times were compared with a great deal of accuracy.

World Radio History

MAKING MEASUREMENTS TO STANDARDS ACCURACY

New requirements heighten the need for quick, simple, inexpensive and highly precise measurements of voltage, current, resistance and ratio. This article describes an entirely new method of making these measurements with speed, simplicity and accuracy.

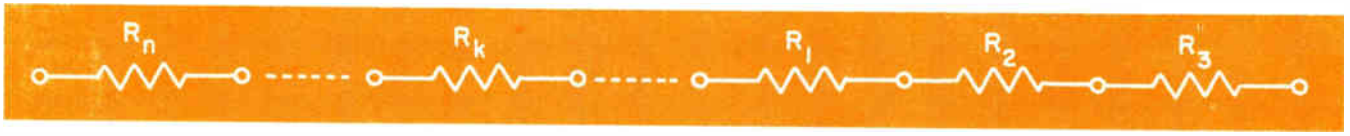


Fig. 1: Central to the Ratiometric method is the string of resistors in series. String is one of the NBS-certifiable standards in the method. In the Julie Standard, resistors have an accuracy of 0.0015% and intercomparison among them permits establishment of ratios of better than 0.00001% accuracy.

A NUMBER OF TRENDS CONVERGING on the industry made it important that a new method of measurement be developed. The first of these forces is the result of several large-scale electronics programs. These are programs that have been undertaken in connection with inertial navigation problems, computer development, and satellite and space-probe projects of all kinds. As a result of all this effort, there has been a great increase in the need for accurate measurements, calibrations, and certifications, and for an increase in the speed with which they can be made. Many labs are under heavy pressure to work faster, to do more work, and to do it more accurately than ever before. This situation was certainly not anticipated when the classical methods were developed; rather, these methods were designed for scientists working quietly in their labs without heavy time pressure. The modern demand for good, fast measurements, though, has changed all this, even in those very labs.

Secondly, there has been a change in recent years in the availability of the services of the nationally recognized source of good measurements —the National Bureau of Standards (NBS). At the same time that industry needs more certifications than ever before, NBS gives signs of wanting to get out of the calibration business. Of course, if NBS decreases its activity, then local plant activity must be increased in the same proportion. Each plant will have to perform the calibrations and certifications that NBS no longer wishes to perform.

The third development is the heavier emphasis the Department of Defense is putting on traceability and certification in government work. Regulations, MIL Specs, and contracts are calling for better and more accurate tests and calibrations.

The fourth factor is the increasing reliance on value as a criterion for measurement technology and equipment. A fuller explanation of how value analysis can be applied to several types of measurements will be found later in this article.

By LOEBE JULIE
President
Julie Research Laboratories, Inc.
New York, N. Y.

The Julie Ratiometric Method

Discovery of the new method originated with the development of some precision resistances assembled in sets. At high values—1,000 ohms, 100,000 ohms, for example, these Julie resistors are probably the most accurate available. (At 1 ohm, of course, the most accurate would be the Thomas resistors.) But aside from accuracy, the other feature of these resistors is their small size.

Once these very accurate and stable resistances were developed they could be assembled in sets of 10 or 12 and packaged in small, hermetically sealed cases. They could, naturally, be interconnected in the set in different patterns. It wasn't long before we found that taking, say, n of these resistors in series and tapping the string at the k-th resistor would set up the hyper-accurate ratio k/n, Fig. 1.

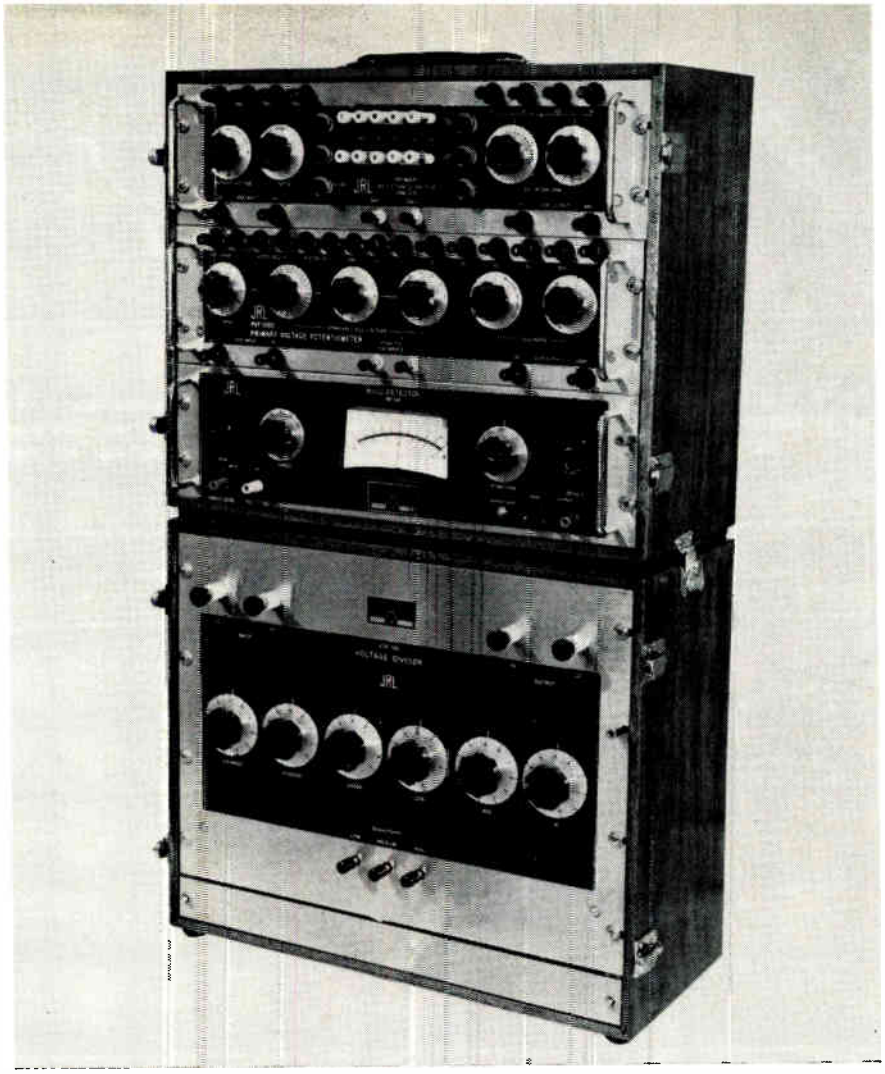
World Radio History

In terms of a 10-resistor string, for example, ratios of 0.1, 0.2, 0.3, etc., could easily be obtained with accuracies better than 1/10 part per million. The resistors are accurate to a few ppm of nominal. Three sets of these hermetically sealed resistance standards were then used as successive decades of a universal, dialable, voltage divider. The last three decades were supplied with individual resistors of nearly the same high quality to make it a 6-digit divider. (The lowest three decades contribute much less error than the first three.) This device proved to be the first (and to our knowledge, the only) Kelvin-Varley divider to have a guaranteed accuracy of 1 ppm. So a two-step advance had been made, from individual resistors of high accuracy, to a 6-dial voltage divider offering ratios accurate to 1 ppm, guaranteed.

Thus, the two central ingredients of Ratiometrics are the k/n resistor string (in which we can establish ratios with accuracies of 1 part in 10 million) and the divider.

So far we have talked only in terms of ratio. But, the basic units with which the engineer deals are not only ratio, but resistance, voltage and current. So our next step was to discover a means of using our ratiometric tools (the string or standard and the divider) to measure these quantities. Development of a number of adaptor instruments, used in conjunction with the basic tools solved this problem. It also enabled us to provide a complete lab for measurements, traceable to NBS units, at a cost usually paid for normal equipment that is slower and less accurate by orders of magnitude.

Figs. 2 and 3 show how the system works in hardware. In Fig. 2 the full-scale (FS) value of the parameter to be measured is established across a ten-million-step divider of extreme linearity, accuracy, and stability. This divider is always conjoined with a null detector of very high sensitivity and low input noise and uncertainty. For each parameter to be measured, an "adaptor" instrument is provided. This is used to establish the needed FS value across the divider to a high absolute ac-



Typical Ratiometric dc laboratory. The console includes modules that are (from top to bottom) a primary resistance bridge, a potentiometer, a null detector and a voltage divider.

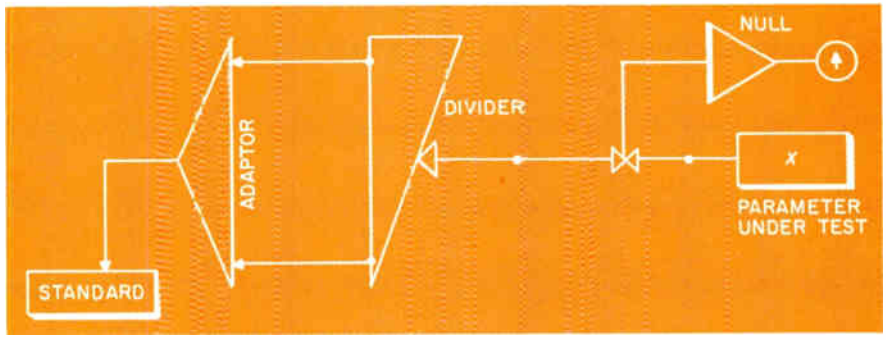


Fig. 2: Graphic representation of the method in hardware shows how few instruments are needed to make measurements of voltage, current, resistance and ratio to standards accuracy.

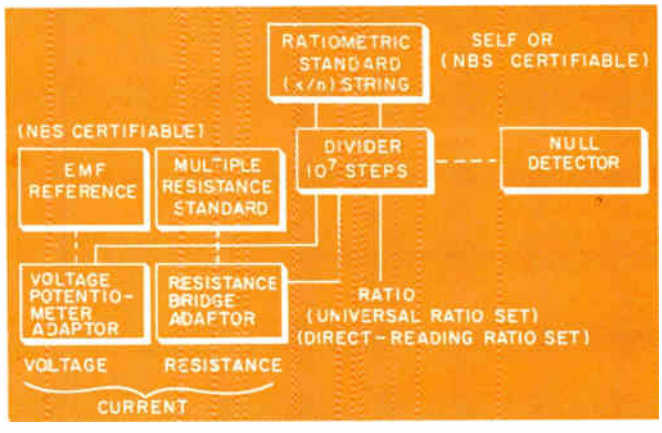


Fig. 3: Complete Ratiometric measurement laboratory. The modules can all be used separately outside the Ratiometric facility, with no impairment in their performance or accuracy.

World Radio History

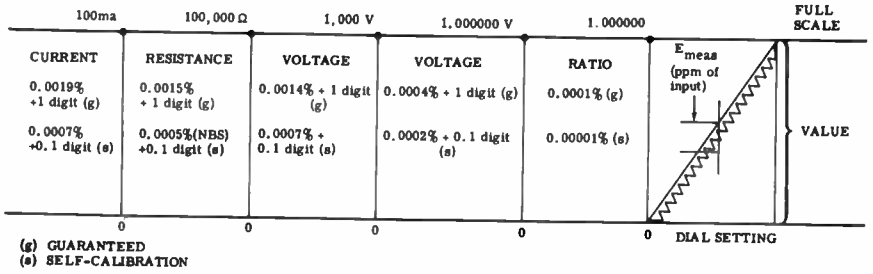


Fig. 4: Diagram shows divider accuracy over typical ranges in its various measurements. Top set of numbers indicates guaranteed accuracy and bottom set accuracy when self-calibrating. The +1 digit or +0.1 digit spec is the divider error. Note that all dial settings are zero.

Level Classical Hierarchy	Accuracy Range	Accuracy Class C_A	Speed Range	Speed Class C_S	Combined Grade	Relative Measurement Value	Relative Measurement Dollar Value
PRIMARY LABORATORIES	0.0001% (note 1)	6	1 wk (note 2)	0	6	10^6 (note 3)	$10,000 (note 4)
SECONDARY LABORATORIES	0.0001%	5	4 hr	1	6	$3x10^5$+	$3,000
QUALITY CONTROL	0.01%	4	24 min	2	6	10^5	$1,000
PRODUCTION CONTROL	0.1%	3	144 sec	3	6	$3x10^4$	$300
	1%	2	15 sec	4	6	10^4	$100

NOTES:
1. Accuracy (fractional parts) $\doteq 10^{-(C_A)}$
2. Speed (per measurement) $\doteq 10^{-(C_S)}$ (in weeks)
3. Relative measurement value $\doteq \frac{1}{A\sqrt{S}} \doteq 10^{(C_A - C_S/2)}$
4. Relative equipment dollar value $\doteq$ K(value) $\doteq$ 0.01 (value) $\doteq 10^{(C_A - C_S/2 - .2)}$

Fig. 5: Proposed value analysis of measurement needs. Problem: measure 778.732 v. (or ohms).

Fig. 6: New demands versus classical hierarchy. Speeds necessary in each use have been kept.

Level	Accuracy	Speed	Combined	Value	Cost
PRODUCTION CONTROL	0.1% (3)	15sec (4)	(7)	10^5	$1,000(2)
QUALITY CONTROL	0.01% (4)	144sec (3)	(7)	$3x10^5$	$3,000(2)
SECONDARY LAB.	0.001% (5)	24min (2)	(7)	10^6	$10,000 (note 2)
PRIMARY LAB. (note 3)	0.0001% (6) (note 1)	4hr (1)	(7)	$3x10^6$	$30,000 (note 2)
	0.00001% (7) (note 1)	1wk (0)	(7)	10^7	$100,000 (note 2)

NOTES:
1. Accuracy and/or speed combination unrealizable with classical equipment.
2. Cost is beyond budget normally available in most cases.
3. Highest accuracy classical equipment is impractical for use in non-primary standard laboratory environment, or at high speed, or by available personnel.

MAKING MEASUREMENTS (Continued)

curacy. The adaptor derives its absolute accuracy from either one of the two references, both traceable to NBS, and both transportable with demonstrably high stability.

Having assembled the four basic elements (reference, adaptor, divider, and null detector) with prefabricated patch-cables, and set up the desired FS range, it is only necessary to connect the unknown and adjust the divider until null is reached. The divider is then direct reading in the percentage of FS—to seven digits, with a total limit of error on most ranges of less than 5 ppm.

Fig. 3 shows the assembly of a complete measurement facility of standards accuracy. It is only necessary, in this facility, to combine a minimum of two standards, a minimum of two adaptors, a voltage divider of the needed linearity and accuracy, a fixed ratio standard to supply self-validation and a null detector having suitably low uncertainty and adequate sensitivity.

Notice that all four outputs: Voltage, current, resistance and ratio are derived from the same set of instruments and equipment. This is significant, in terms of equipment cost savings, when you remember the accuracies of these measurements, Fig. 4.

Certification, Speed and Simplicity

As Fig. 3 shows, the emf and resistance standards are NBS-certifiable. Ratio standards are either self or NBS-certifiable so that all readings can be referenced back to basic NBS units. Except for the two needed links to NBS, the method is completely self-validating and most of the validating procedures can be done in minutes.

In fact, readings of voltage, current, resistance and ratio can be derived from the system within a few minutes—often within 10-15 sec.—by semi-skilled operators. Because of the speed and simplicity of operation, many, if not most, of the uses for this method will be in quality control (QC) or production control

World Radio History

stations. This is true despite the fact that accuracies are at the level of the standards lab. As mentioned earlier, the new demands for accuracy, speed and simplicity are being felt at many levels. That's one of the reasons it was so important to create a method that could be used throughout the hierarchy of measurements—primary labs, secondary labs, QC and production control.

Value Analysis of Measurements

We have come a long way in the industry with value analyses. To examine a new method of measurement, it would be helpful for the engineer concerned with this problem to have a value analysis tool.

Such a simple analysis is proposed here. It begins with Fig. 5 which weighs accuracy and speed in the classical hierarchy of measurements. (Many other factors might enter into such an analysis — cost, downtime, reliability, size, etc.—but we have restricted this analysis just to these two parameters to simplify matters and to keep it within measureable terms.)

This proposed analysis is applied to the whole measurement operation, e.g., measuring 778.732 volts or ohms, as opposed to the partial one of measuring precisely 1 volt or ohm.

Typical accuracies needed for primary labs, secondary labs, QC and production control are listed. To each of these accuracies we have assigned a numerical grade. The same procedure was followed to give a value to speed. Those familiar with the speed and accuracy needs in most labs and plant control stations will see that the values we've set down are at least approximately in the correct range.

Using the formula at the bottom of the chart, it can be seen how a relative measurement value can be computed and from that a dollar value for the measurement. Again, those familiar with the costs of equipment for performing these various measurements will recognize that the dollar values are not very far out of line for normal equipment.

But what happens when new, more demanding needs are set? Fig. 6 illustrates the answer. In this chart, we have kept the speeds necessary in each use, but have attempted to bring the accuracies into line with new needs. The numbers in parentheses under both accuracy and speed are our grades—ascending values as accuracies ascend and descending values as time is lengthened.

Using the same formula we used with Fig. 5 for computing measurement value and cost, we get some startling answers. We can see that, for many uses, the cost is simply out of line with most budgets. We have also noted on this figure those accuracy-speed combinations that are unrealizable with normal equipment.

Fig. 7 shows some actual case histories from our files. The accuracies and speeds needed by aerospace systems and digital measurements systems are not uncommon in today's electronic world. Again in this figure the numbers in parentheses are the values we assigned in the previous example. Notice that in our first assessment (Fig. 5) the highest value we derived for the accuracy-speed addition was 6; in Fig. 6 it was 7. In actual practice, as Fig. 7 shows, it gets up to 8, 9 and 10. If the values of 7 were unrealistic in terms of cost (Fig. 6) how much more would these new values be!

So in real, practical terms, a new method of measurement was needed. This new method had to provide accuracies that were not anticipated when classical systems were evolved. What's more, the speed at which laboratories must work (not to mention production line uses) has become greater and greater. As these pressures get heavier, classical systems became more and more outmoded.

Fig. 8 is a value analysis of the new method. It shows that we can produce accuracy - speed combinations with this new method that outstrip the classical methods. It also shows that the actual system cost is less than 0.1 times that of the classical measurement-dollar formula.

Critical User Applications	Requirement				
	Accuracy	Speed	Combined	Value	Cost
AEROSPACE (e.g., Inertial Navigation)	0.001% (5)	2 min. (3)	(8)	3M	30K
DIGITAL MEASUREMENT SYSTEMS (e.g., Automatic Measurement, Sorting, Data Recording)					
1 - SLOW SPEED SYSTEMS	0.01% (4)	2 sec (5)	(9)	3M	30K
2 - HIGH SPEED SYSTEMS	0.01% (4)	0.15 sec (6)	(10)	10M	100K

* Taken from actual Julie files, ca. 1959.

Fig. 7: New demands. Data for this chart was taken from actual case histories of companies and agencies whose measurements needs reached as high as 10 on Value Analysis grades.

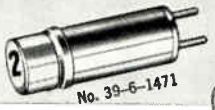
Fig. 8: This is a value analysis of the new method of measurement. It is applied to measuring 778.732 volts (or ohms). It points out the economic benefits of the new method.

Accuracy		Speed		Combined Grade	Relative Value	Measurement Dollar Value ($)	Actual System Cost ($)
Range (%)	Grade	Range	Grade				
0.0001	6	4hr	1	7	$3x10^6$	30,000	2,500
0.001	5	144sec	3	8	$3x10^6$	30,000	2,500
0.003	4.5	15sec	4	8.5	$3x10^6$	30,000	2,500

REMARKS:
1. Grades 1 to 2.5 units higher than in classical system.
2. Measurement value higher ($3x10^6$) over wide speed range. Speed grades 1 to 4 are a speed range of 10,000:1.
3. Actual cost less than 0.1 times that of classical measurement-dollar formula.
4. Same system functions in all environments and at all speed levels.

World Radio History

Data Matrix No. DM-7538-18
with Cartridges No. 39-6-1471


No. 39-6-1471


Holder No. 7538
with Cartridge No. 39-6-1471


No. 249-7840-931

For computers, data processing, and other readout applications, DIALCO offers

The complete line of

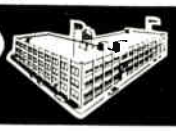
DATALITES®


"Data Cap"
No. 250-7538-1471

Ultra-miniature DATALITES are available in several basic styles: CARTRIDGE HOLDERS that accommodate DIALCO'S own replaceable Neon or Incandescent LAMP CARTRIDGES. Unit mounts in 3/8" clearance hole...For multi-indication, LAMP CARTRIDGES are mounted on a DATA STRIP or DATA MATRIX in any required configuration...DATALITES with *permanent* (not replaceable) Neon Lamps may be had with or without built-in resistors...The "DATA CAP" series features a *rotatable* read-out lens cap; accommodates a clear (colorless) cartridge. LEGENDS may be hot-stamped on cylindrical lenses...Styles shown here are only typical. Send for information on the complete line.

Write for 8-page Datalite Brochure L-160C.

DIALCO®



Foremost Manufacturer of Pilot Lights

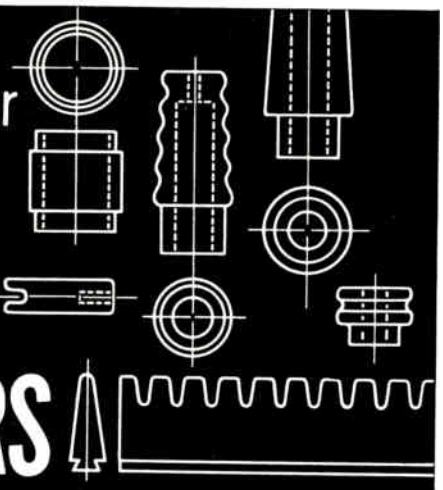
DIALIGHT
CORPORATION

60 STEWART AVE., BROOKLYN 37, N.Y. • Area Code 212, HYacinth 7-7600

Circle 88 on Inquiry Card

A Quality Source for

MACHINED CERAMIC INSULATORS



Extruded or Pressed ALUMINA or STEATITE

Beveling • Notching • Slotting • Grooving • Counterboring
Milling • Tapering • Threading (internal or external)
Glazing: white or colors—
complete or selected area

Exceptional accuracy can be maintained at low cost where tolerances are not less than ±1%. Consulting our engineers at the design stage may effect additional savings.

Saxonburg CERAMICS, INC.
800 THIRD AVE.
SAXONBURG, PA.

Quality Ceramics for Industry Since 1924

EDITOR'S NOTEBOOK

HEART MONITOR, pocket-sized, for medical use just after accidents, is announced by Physiological Institute of Heidelberg University. Especially useful after electric shock, the seven-transistor instrument, called Teldicord, makes heart currents audible. It has a printed circuit and weighs 13 oz. Two electrodes are attached to arms or legs, and heart action currents, if any, become audible whistles. It may prove useful in hospitals.

WIRELESS TV CAMERA is now possible with a new television pick-up tube. The camera, Minicam Mark II, was used by CBS at the recent Republican National Convention. Camera is 6½ lbs., and is 5 x 4 x 10 in. Entire package — camera, power unit and transmitter—is 29 lbs. Heart of the camera is the "Plumbicon" developed by Philips of the Netherlands, and marketed through North American Philips Co., Inc. of New York. It has high stability, high sensitivity and does not smear.

DIAMOND PHONO STYLUS, with a lifetime warranty and made by man, is a recent GE item for the hi-fi consumer. Trademarked "Man-Made" by GE, the new stylii can now be controlled in the making process to produce diamonds of uniform crystal size, shape and purity. According to RCA spokesmen, Man-Made stylii will be less susceptible to tip chipping which damages records.

WARFARE LANGUAGE problems may be solved with a device tested by IT&T Corp. It allows field commanders to communicate quickly even in different languages. Called a digital encoder-decoder, it operates with ordinary voice radios to send or receive 100 pre-determined messages in digits. Soldier selects message number, puts it into unit, and pushes a "send" button. Receiving soldier checks code number for language translation. Only another adapter and code book can receive and decipher.

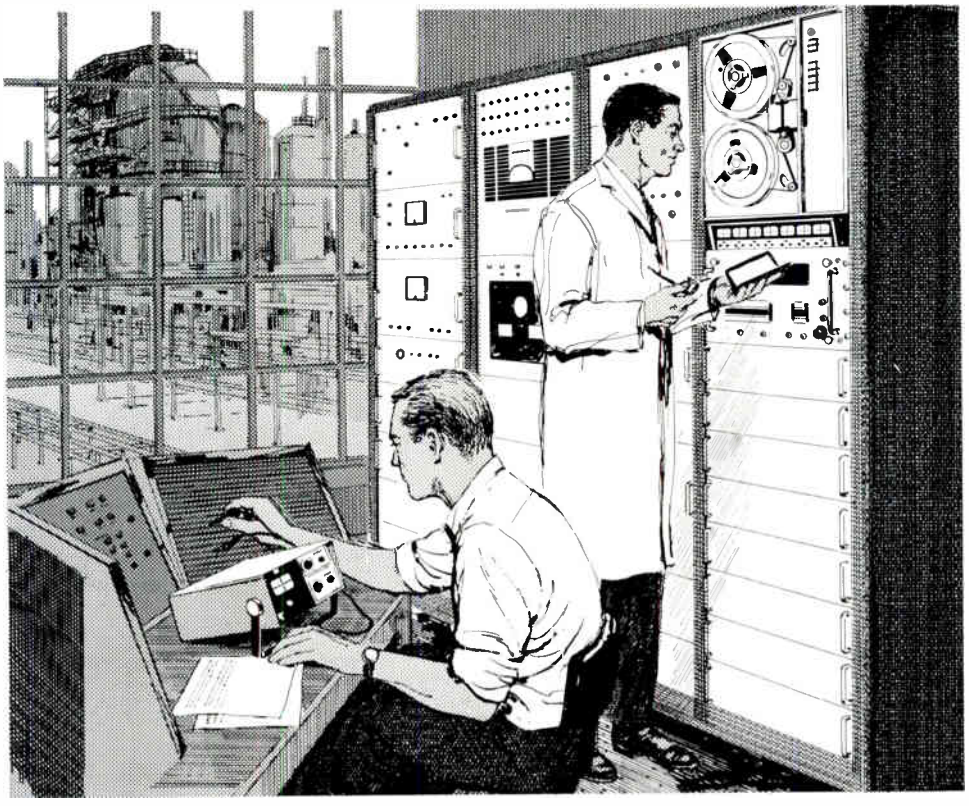
INSTANT MEMORY won't let you forget car lubrication or rotation of tires. Friendly Chevrolet Co. in North Texas is delivering cars equipped with compact computers tucked away under the dash. Called Servicator, the IBM instrument, at the right moment, releases a card that tells you it's time to have something checked, such as oil, battery, engine tune-up, etc.

World Radio History

ELECTRO INSTRUMENTS ANNOUNCES

NEW LINE

OF SMALL INDUSTRIAL OSCILLOSCOPES



PRECISE, COMPACT, SIMPLIFIED OPERATION
...BATTERY-OPERATED MODELS INCLUDED

By Dr. Walter East
President, Electro Instruments, Inc.

This news should get a warm welcome—in industry, laboratories, medical and educational institutions.

No longer are the many advantages of measuring oscilloscopes in part offset by the fact that trained technicians are needed for their operation.

Many complex oscilloscope features —which contribute nothing to many measuring operations—have been completely eliminated from the new line of Electro Instruments' oscilloscopes.

This new line includes two basic types. A monitoring type, which houses seven scopes in an area no larger than an attache case; and a laboratory type no larger than a shoe box. Models of the latter type may be operated on a battery pack, making them ideal instruments for field use.

The "Picture" Advantages

The "camera-like" oscilloscope has decided advantages over mechanical motion measuring instruments. It instantly conveys to users of various electronic instruments a picture of working conditions within the instruments . . . increases comprehension of their functioning. Being almost inertialess, it reproduces electronic phenomena more faithfully than instruments of other types.

Get Efficiencies, Savings

Now—at reduced expense, and utilizing present personnel—your industrial or scientific operations can be modernized to bring you the greater efficiencies and savings offered by Electro Instruments' oscilloscopes. Let an E I SALES engineer give you full facts about the many superior features of the new Electro Instruments' line.

Electro Instruments, Inc.
8611 Balboa Avenue • San Diego 12, California

E I SALES, SAN DIEGO, CALIF. • ELECTRO INTERNATIONAL, INC., ANNAPOLIS, MD. • TRANSFORMER ENGINEERS, SAN GABRIEL, CALIF.

World Radio History

NEW! FREE! NEW! FREE! NEW!

FREE! NEW! NEWARK 1965 INDUSTRIAL ELECTRONICS CATALOG!

LISTING ALL

AEROVOX®

INDUSTRIAL COMPONENTS and featuring

MIL TYPE CK05-CK06 CERALAM CAPACITORS

Will meet MIL-C-11015/18/19 specs, and will operate without derating at 200 VDC from —55°C to +125°C. Life tested at 400 VDC, 150°C. CK05 available in capacities from 10 μμf; CK06 available from 1200 μμf to 10,000 μμf. Molded case.

Oimensions:
CK05:—.195 X .195 X .095"
CK06:—.295 X .295 X .095"

• *Immediate Delivery from Stock*
Factory OEM Prices

NEWARK CATALOG 80

• Industry's Most Complete Catalog
• Over 640 Pages • Over 70,000 Items
• Over 600 Standard Brand Lines
• Eight Stocking Warehouses
• Over $6,000,000 Industrial Electronics Inventory

NEWARK ELECTRONICS CORPORATION

Main office and warehouse • Dept. EI
223 West Madison • Chicago, Ill. 60606

Authorized Aerovox Warehouses in:

CHICAGO, ILL.
(312) ST 2-2944
CINCINNATI, OHIO
(513) 421-5282
DENVER, COLORADO
(303) SK 7-3351
DETROIT, MICHIGAN
(313) JO 4-5490
GRAND RAPIDS, MICHIGAN
(616) 452-1411
LOS ANGELES AREA
(213) OR 8-0441
SAN FRANCISCO AREA
(415) 593-1881
NEW YORK CITY
(212) AL 5-4600

Circle 94 on Inquiry Card

EDITOR'S NOTEBOOK

COMPUTER SYSTEMS are being added to those already at the U.S. Military Academy at West Point. The staff tried teaching computers and programming to all plebes last two years, and found it valuable. All students now are required to learn to operate and program a minimum of five problems on the computer. Using GE equipment, Academy spokesmen say they will have one of the most comprehensive teaching programs in the country.

TEACHING SYSTEMS are being designed for production by Hickok Electrical Instrument Co.'s new subsidiary — Hickok Teaching Systems, Inc. Responding to need for more skilled workers in the electronic industry, courses will be engineered to provide all elements — from basic texts to industry-standard instruments —for sound curriculum in electronic technology.

STOMACH TRANSMITTERS are being fed by gastroenterologists to patients at University of California Hospital, San Francisco, to measure and transmit data on stomach acidity. Data determine value of drugs used to treat ulcers. Units are in form of capsules easily swallowed. Transmitters emit tiny signals that show up on an acid-graph.

EDP STATUS SYMBOL. At one time, things like the corner window, a carpet, or a carafe, symbolized executive status. Now, it seems to be the size of bandwidth used by an executive's operations in EDP circles. Participants at an American Management Association session on "New Technologies" see it this way. The greater the volume and quality of data sent and received by an executive's department, the broader the transmission bandwidth needed.

AIR-CONDITIONER, all-electronic, completely silent, is being tested for use in U.S. Navy Submarines. Developed by RCA, with no moving parts, it uses highly developed thermoelectric cooling. For 9-ton capacity, the unit is 4 ft. long, 3 ft. high and a foot deep. Using solid-state components, current is passed between n and p types. Air is cooled when passed through heat exchanger elements on the side which takes up the heat. The unit has 40,000 pairs of bismuth telluride semiconductors. Output is 105,600 BTU's per hour.

NOW COLD HEADED ON A MASS PRODUCTION BASIS

HIGH STRENGTH
HIGH CONDUCTIVITY

BERYLLIUM COPPER

FASTENERS

AVAILABLE IN STANDARDS, SPECIALS, SUBMINIATURES AND MINIATURES, IN ALL STANDARD HEAD STYLES AND SHAPES

Diameters from .020" to .375"
Lengths from .062" to 6"

FOR EXTRA RELIABILITY

High Tensile Strength . . . up to 200,000 psi; stronger than some stainless steels.

Excellent Corrosion Resistance . . . equal to or better than high copper alloys.

Good Electrical Conductivity . . . 22% to 55% of International Annealed Copper Standard.*

Spark Resistance . . . affords protection in areas where flammable solids or explosive gases are present.

Good Thermal Conductivity . . . up to 60% of pure copper.*

Wide Operating Temperature Range . . . offers remarkable resistance to loss of physical properties up to 600°F.*

High Fatigue Strength and Wear Resistance . . . better than 18-8 stainless steel and most other cold heading metals.*

*Depending on alloy and heat treatment.

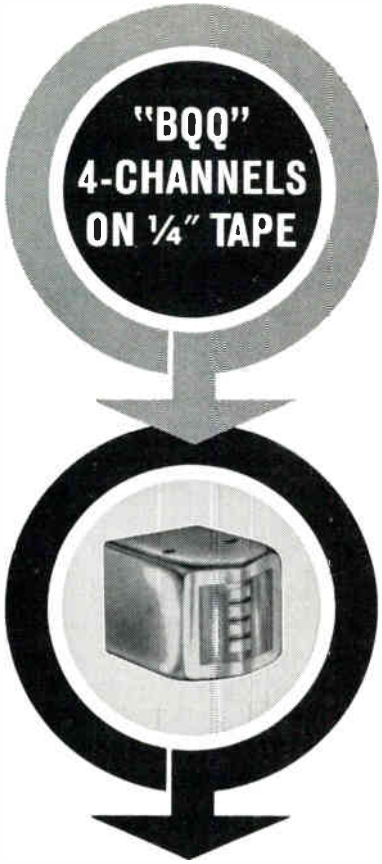
AT REASONABLE COST
. . . up to 70% less than identical parts made on screw machines.

write for engineering bulletin

HARVEY
HUBBELL
INCORPORATED
MACHINE SCREW DEPARTMENT
BRIDGEPORT 2, CONNECTICUT

Circle 95 on Inquiry Card

World Radio History



New! Low-cost Instrumentation Head tooled for high volume... fast prototype delivery!

Deposited quartz gaps down to 50-millionths. Gap is extra-hard with precision edges — eliminates smear!

Multiple channels for less—with Nortronics new, compact "BQQ" heads. Designed for digital, instrumentation, analog and audio recording or reproduction, "BQQ" heads are readily available in production quantities — will fit existing 4-track systems. Types include Record only and Record/Reproduce heads in no-mount, base-mount, rear-mount and side-mount styles.

TYPICAL APPLICATIONS

Used for instrumentation recording including carrier modulated types such as: AM, FM or Pulse; as straight Digital and Analog recording. Ideal for Audio Duplication, Background Music and 4-Channel "in-line" Stereo. In multiple staggered channel use, the "BQQ" accommodates 14 channels on 1" tape and 7 channels on ½" tape.

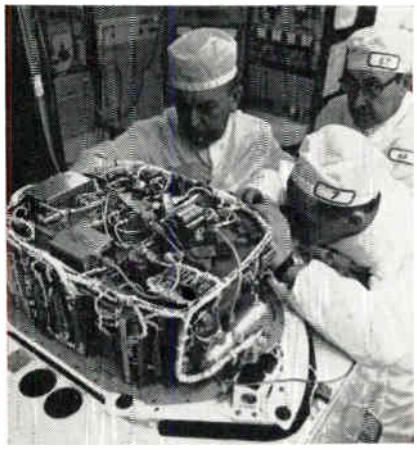
For complete information on Nortronics heads, write for our Form #7177.

Nortronics®

8149 10th Ave. No., Minneapolis, Minn 55427

Circle 96 on Inquiry Card

GEMINI RADAR



First production prototype rendezvous radar for manned space flight on NASA's two-man Gemini has been delivered to McDonnell Aircraft by Westinghouse. Radar will be used to guide astronauts to target when they reach a point 250 miles from each other.

HARPER Q. NORTH OF TRW NAMED EIA PRESIDENT

Dr. Harper Q. North, vice president of R&D for Thompson Ramo Wooldridge Inc., Redondo Beach, Calif., has been elected president of the Electronic Industries Association.

As an EIA vice president, Dr. North has represented the association's Semiconductor Division since 1962. He was elected to head the national association of electronics manufacturers for a one-year term which began August 1.

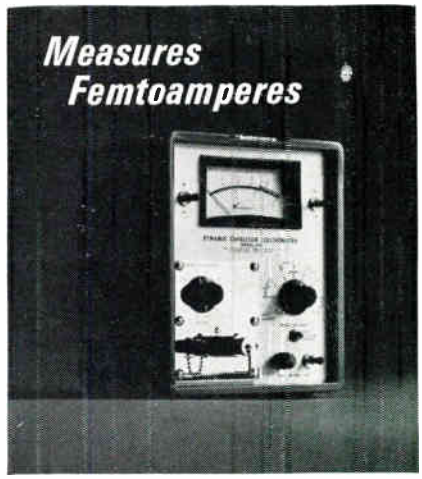
As TRW vice president since 1962, Dr. North has been responsible for coordinating all R&D activities for the firm, a world-wide manufacturer of electronic components and space systems.

He founded Pacific Semiconductors Inc., a TRW subsidiary, in 1954 and served as president until 1961, when he was named board chairman of TRW Electronics Inc.

NINE-CHANNEL DUPLEX MADE BY ITT BRITISH SUBSIDIARY

A transistorized transmission system that will accommodate up to 9 telegraph channels plus a voice channel on one voice circuit has been produced by a British affiliate of International Telephone and Telegraph Corp.

Standard Telephones and Cables, Ltd., said that their Type-TF. 801 system will provide up to 9 duplex telegraph channels as well as speech or picture transmission over a single 4-wire, 4-kc, carrier telephone channel or physical circuit.



VICTOREEN Dynamic Capacitor Electrometer

The Victoreen Femtometer Dynamic Capacitor Electrometer is an ultra-precise transistorized measuring instrument of great stability and ultimate sensitivity. At about ⅓ of full-scale, the Femtometer measures currents of less than 1 femtoamp (10^{-15} amp.) and voltages from ultra-high-impedance sources.

This remarkable capability makes the Femtometer the ideal measuring instrument in nuclear studies involving ion currents . . . in electronics for measuring transistor base or tube grid currents . . . in chemistry for pH and chromatography . . . in physics for serious research applications.

All the most desired deluxe features —unitized plug-in preamplifier for remote operation, multiple switch-selected input resistors, built-in remote shorting switch, etc.—are yours at the attractive base price.

Victoreen representatives are demonstrating the Femtometer throughout the country. Write us on your professional letterhead for a demonstration at your convenience.

CONDENSED SPECIFICATIONS

Ranges: 3 millivolts to 30 volts; 3 x 10^{-15} . . . 3 x 10^{-7} amps.
Power Requirements: 115 or 230v, 50-60 cps; or 4 "D" flashlight batteries. Switches itself to battery if AC fails. (No batteries needed for AC-only operation.)
Input Connector: Adaptors furnished to fit std. MIL type connectors.
Accuracy: 2% or better on panel meter or potentiometer recorder readout; order of 0.25% with calibrated capacitor and rate of charge measurement using external potentiometer.

A-9356A

WORLD'S FIRST NUCLEAR COMPANY

VICTOREEN

THE VICTOREEN INSTRUMENT COMPANY
5806 HOUGH AVE. • CLEVELAND 3, OHIO

Circle 97 on Inquiry Card

World Radio History

BURR-BROWN chopper stabilized OPERATIONAL AMPLIFIER

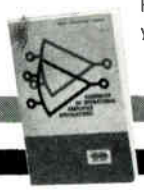
PROVIDES

■ High Voltage Gain	160 db @ DC
■ Low Voltage Drift	±1 μv/°C
■ Low Current Drift	±0.01 na/°C
■ Low Current Input Offset	±0.1 na

Burr-Brown's new 1618 solid-state DC operational amplifier is ideal for integrator, comparator and amplifier applications requiring extreme stability. Rated output is ±10 V @ 20 ma and frequency response is 0 db @ 1 Mcps. Zero can be adjusted internally. Priced at $235 in unit quantity. FOR COMPLETE TECHNICAL INFORMATION write, wire or phone, today.

OPERATIONAL AMPLIFIER HANDBOOK

96-pages of valuable theory and circuits. A note on your letterhead will get you a free copy



BB **BURR-BROWN**

RESEARCH CORPORATION
Box 6444 TUCSON, ARIZONA
Telephone: 602-623-0328 • TWX: 602-792-2681

Circle 99 on Inquiry Card

LOWER COST ON SCHOOL TV RESULTS FROM FCC RULING

Lower costs for closed circuit TV equipment used by schools will result from a new ruling by the FCC, reports Stanley Lapin, director, Adler Educational Systems division of Litton Industries, New Rochelle, N. Y.

The ruling permits each school served by an instructional fixed station to receive as many as four TV channels at the same time with a single broadband converter. Previously, a converter was needed for each channel. Adler Educational Systems has developed a broadband converter for such use.

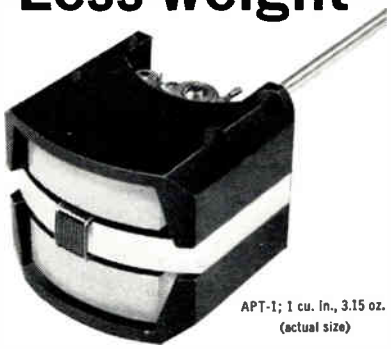
A district with 10 schools can save up to $30,000 on converters, Mr. Lapin observes. Instructional TV is now within range of smaller school districts and colleges.

RCA ENTERS HI-FI MARKET

RCA Sales Corp. has entered the rapidly growing high fidelity components market with its first line of RCA Victor laboratory-balanced stereophonic sound modules.

The line includes a Studionatic record changer, a solid state tuner-amplifier, three sets of speaker systems and a console tuner-amplifier-changer.

More torque, Less weight



APT-1; 1 cu. in., 3.15 oz. (actual size)

in moving coil mechanism

Stable, linear, accurate mechanism for indicating, control or recording systems. 1% linearity over 18-0-18° and greater accuracy assured by coil design with over 75% of winding "working" in high energy, uniform field air gap. Coil system weighs 0.85 gm, develops 26.4 mmg of torque; 31:1 T/W. Vibration resonance negligible; acceleration errors sharply attenuated. Standard pivots and jewels—custom damping—wide range of sensitivities.

AMMON

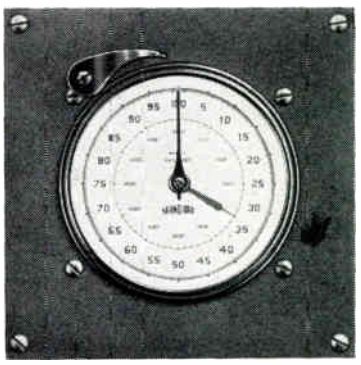
AMMON INSTRUMENTS, INC.
345 Kelley Street, Manchester, N. H. 03105

Circle 100 on Inquiry Card

this hand

spinning on this face

measures elapsed time with ± .001 sec. accuracy



MST-100

For complete information and details on STANDARD "SPLIT-SECOND" TIMERS write for our free 20-page catalog No. 257

Model	Scale Divisions	Totalizes	Accuracy
S-100	1/5 sec.	6000 sec.	±.1 sec.
S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min.
S-1	1/100 sec.	60 sec.	±.01 sec.
MST-100	1/1000 sec.	6 sec.	±.001 sec.
MST-500	1/1000 sec.	30 sec.	±.002 sec.

STANDARD TRADEMARK

THE STANDARD ELECTRIC TIME COMPANY

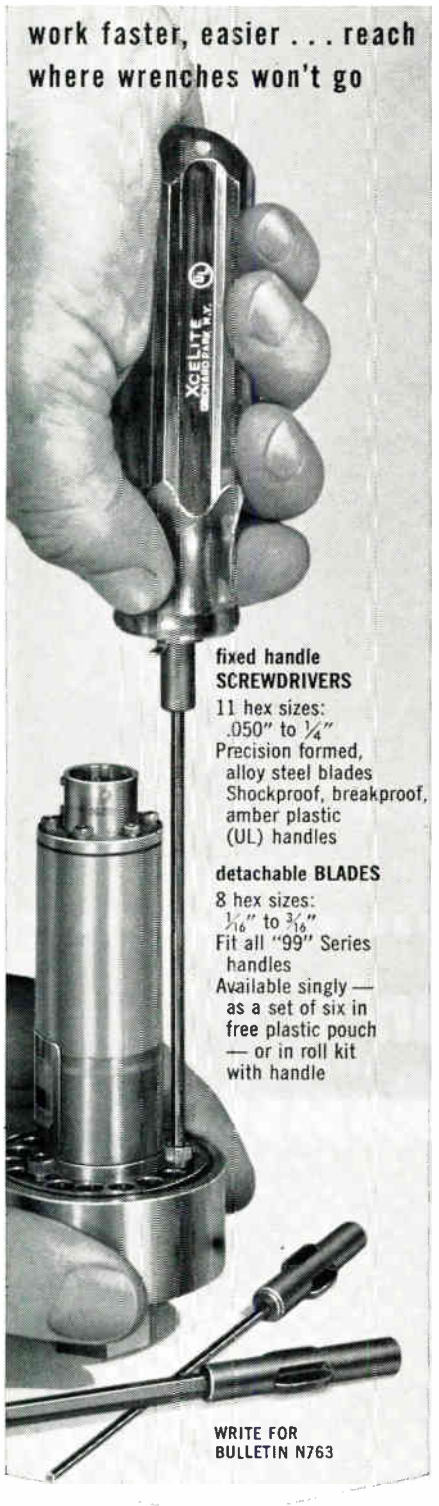
89 LOGAN STREET
SPRINGFIELD 2, MASSACHUSETTS

Circle 101 on Inquiry Card

World Radio History

new Allen type screwdrivers

work faster, easier . . . reach where wrenches won't go



fixed handle SCREWDRIVERS
11 hex sizes: .050" to ¼"
Precision formed, alloy steel blades
Shockproof, breakproof, amber plastic (UL) handles

detachable BLADES
8 hex sizes: 1/16" to 3/16"
Fit all "99" Series handles
Available singly — as a set of six in free plastic pouch — or in roll kit with handle

WRITE FOR BULLETIN N763

XCELITE®

XCELITE, INC., 28 BANK ST., ORCHARD PARK, N. Y.
Canada: Charles W. Pointon, Ltd., Toronto, Ont.

Circle 102 on Inquiry Card

WOMEN ENGINEERS ELECT I. F. FRENCH PRESIDENT

At the 1964 Convention in New York City the Society of Women Engineers elected Isabelle F. French to serve as the Society's ninth national president. She is an associate member of the Bell Telephone Laboratories technical staff.

Miss French, of Bath, Pa., holds a B. S. degree in radio engineering from Tri-State College. Before joining Bell Laboratories, she was on the staffs of Sylvania Electric Products Co. and Capehart-Farnsworth Corp.

REL MARKETS SOLID-STATE TROPO-SCATTER RADIO GEAR

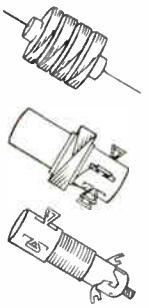
Radio Engineering Laboratories, Communications Division of Dynamics Corporation of America, has developed a new solid-state series of tropospheric scatter radio equipment.

The equipment, 2600 series, can be applied to line-of-sight relay and satellite ground station modes of operation.

While improving performance (NPR is 55 db or better) for similar equipment of tube design, the solid-state equipment is more than 80% smaller and lighter.

Specifically Engineered for RF Components!

A-27 Superfine
Q-max
EXTREMELY LOW-LOSS
RF LACQUER



Q-MAX impregnating and coating composition penetrates deeply, seals out moisture, provides a surface finish. Q-MAX imparts rigidity and promotes stability of the electrical constants of high frequency circuits. Effect on the "Q" of RF windings is negligible.

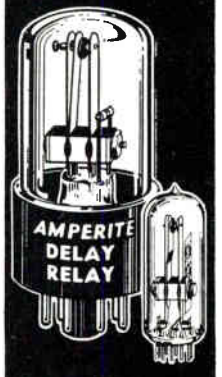
Write for catalog today.

Q-max Corporation
MARLBORO, NEW JERSEY
Telephone: 462-3636 (Area Code 201)

Circle 104 on Inquiry Card

AMPERITE

Thermostatic DELAY RELAYS

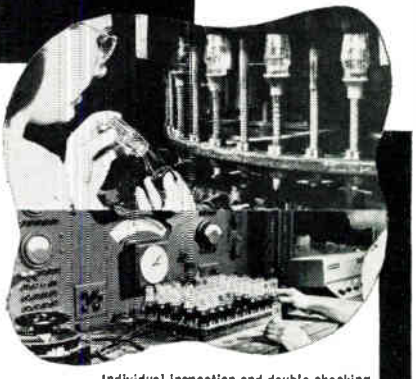


Delays: 2 to 180 seconds

Actuated by a heater, they operate on A.C., D.C., or Pulsating Current . . . Being **hermetically sealed**, they are not affected by altitude, moisture, or climate changes . . . **SPST only**—normally open or normally closed . . . Compensated for ambient temperature changes from —55° to +80° C. . . . Heaters consume approximately 2 W. and may be operated continuously . . . The units are **rugged, explosion-proof, long-lived**, and—inexpensive!

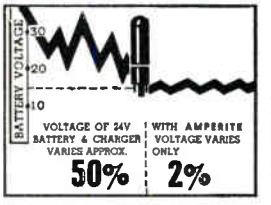
TYPES: Standard Radio Octal, and 9-Pin Miniature.
List Price, $4.00

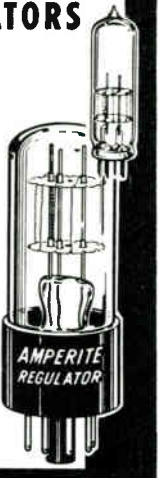
PROBLEM? Send for Bulletin No. TR-81



Individual inspection and double-checking assures top quality of Amperite products.

AMPERITE BALLAST REGULATORS





Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—50° to +70° C.), or humidity . . . Rugged, light, compact, most inexpensive.
List Price, $3.00

Write for 4-page Technical Bulletin No. AB-51

AMPERITE
600 PALISADE AVE., UNION CITY, N.J.
Telephone: 201 UNion 4-9503
In Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto 10

Circle 105 on Inquiry Card

World Radio History

CLIP & SAVE

DAVEN PRECISION WIRE WOUND RESISTORS

INSTRUMENT GRADE STYLES

Daven Type	Dia.	Length	Max. Watts @ +150°C	Max. Res.	Lead AWG	Features
DAX ½	3/32	5/16	.15	4K	#22	Economy Line with improved performance characteristics at considerably lower prices.
DAX 1	3/32	13/32	.33	7.5K	#22	
DAX 2	7/32	½	.66	20K	#22	
DAX 2B	5/16	5/16	.66	15K	#20	
DAX 3	¼	5/8	1.0	30K	#20	
DAX 3A	¼	11/16	1.0	35K	#20	
DAX 5	5/16	13/16	1.5	60K	#20	

SUBMINIATURE STYLES

Type	Dia. (Inches)	Length (Inches)	Max. Watts @ +125°C	Max. Volts	Max. Res. .001" Wire	Leads AWG	Max. Res. .0005" Wire
1409	.1	.235	.03	100	7.5KΩ	#24	50KΩ
1282	.125	.312	.05	100	16KΩ	#22	100KΩ
1402	.142	.375	.1	150	30KΩ	#24	175KΩ
1403	.160	.500	.125	200	50KΩ	#22	400KΩ
1274	.187	.375	.125	200	60KΩ	#22	600KΩ

Features — Epoxy encased for max. insulation, & dielectric qualities designed for structural strength. Meets or exceeds MIL spec rates.

HI-RELIABILITY — AXIAL LEAD STYLES

Daven Type	Dia. (Inches)	Length	Max. Watts	Max. Volts	Max. Res. .001" Dia. Wire	Lead AWG
HR1282	.125	.312	.05	100	16K	#22
HR1258	.250	.30	.125	100	127K	#22
HR1250	.250	.50	.15	200	226	#20
HR1195	.250	.75	.25	300	511	#20
HR1257	.312	.812	.50	300	750K	#20
HR1252	.375	1.0	.75	600	1.5 Meg.	#20
HR1172	.500	1.0	1.0	600	2.0 Meg	#20

Features — Current failure rate of .02%/1000 hrs at 60% confidence. Over 10 million test hours accumulated with 8,627 units
Conditions: At +125°C and max rated power.
Definition of failure: △R ±.5%.

POWER WIRE WOUND (Per MIL-R-26)

Daven Type	MIL Type	Char. "V" Watts	Dia.	Length	MIL Max. Res.	Commercial Max. Res.
DAC-7	RW55	7	½	1⅜	5K	90K
DAC-10	RW56	14	½	2	9K	175K
DAS-5	RW57	6.5	5/16	13/16	3.5K	60K
DAS-10	RW58	11	3/8	1 13/16	8K	175K
DAS-2	RW59	3	7/32	½	.9K	20K

HI-FREQUENCY STYLES — AXIAL LEAD

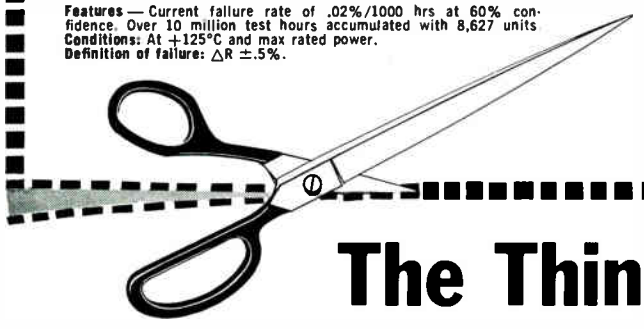
Daven Type	Dia.	Length	Min. Res.	Max. Res.	Max. Watts	Features
1301	¼	½	5K	150K	.15	Designed to provide a rise time of less than .1 μsec (from 10% to 90% of peak pulse amplitude).
1302	3/8	5/8	5K	150K	.15	
1303	¼	¾	5K	250K	.25	
1304	3/8	¾	5K	250K	.3	
1305	¼	1	5K	500K	.5	

MIL-R-93 AND MIL-R-9444 STYLES

Daven Type	MIL-R -93C	MIL-R -9444	Dia. (Inch.)	Lgth. (Inch.)	MIL Watts	MIL Max. Volts	MIL Max. Ohms	Lead AWG
* 1283	RB56	—	¼	11/32	.125	—	127K	#20
* 1250	RB55	AFRT10	¼	½	.15	—	226K	#20
* 1195	RB54	AFRT11	¼	¾	.25	300	511K	#20
* 1251	RB53	AFRT12	3/8	¾	.33	300	750K	#20
* 1252	RB52	AFRT13	3/8	1	.5	600	1.5 Meg.	#20
1172	RB57	AFRT14	½	1	.75	600	2.0 Meg.	#20
1178	RB58	AFRT15	½	1½	1.0	900	3.0 Meg.	#20
1179	RB59	AFRT16	½	2	1.25	1200	5.11 Meg.	#20
1173	RB08	AFRT17	½	½	.25	300	5.11K	#20
1269	RB16	AFRT18	5/16	5/8	.33	300	1.0 Meg.	#20
1270	RB17	AFRT19	5/16	1	.5	600	2.0 Meg.	#20
1176	RB18	—	¾	1¼	.75	600	3.01 Meg.	#20
1271	RB19	—	13/16	2 3/32	1.0	900	6.04 Meg.	#20
1355	RB70	—	3/8	½	.25	150	301K	#20
1350	RB71	—	¼	5/16	.125	—	100K	#22

Features — Many of these styles are available in decade values to ±.01% from factory stock to insure prompt delivery.

In stock for 48 hour delivery in standard decade values



The Thinking Man's Guide to Wire Wound Resistors

If you're thinking about precision wire wound resistors, you've stopped at the right page. Above, in a few square inches, is a short Guide from the folks who have been making them for over 30 years.

Daven, one of the originators of precision wire wound resistors, is today the world's leading source.

Here are the reasons:

- Daven wire wound resistors come in more lead types, including axial wire, radial wire, printed circuit wire, radial lug, printed circuit lug, plus most other wire lead materials and platings.
- Daven wire wound resistors come in 385 styles, including epoxy, varnish or silicone coated; metal encased; solder sealed.
- Daven wire wound resistors come in more sizes, from .1" diameter by .235" long to ⅞" diameter by 2⅛" long.
- Daven wire wound resistors range from 1 milliohm to 25 megohms.
- Daven wire wound resistors feature the highest reliability, with over 11,000,000 test hours at a calculated failure rate of .02% per 1000 hours on full power at 125° C!

There's more to know, of course. For an extensive course on the subject, or details on a particular type, write today!

DAVEN
MANCHESTER, NEW HAMPSHIRE
(603) 625-9746 • TWX 603 623-4938 • Cable: Daven Manchester N H

McGRAW EDISON

923A

World Radio History

ELECTRONIC INDUSTRIES PROFESSIONAL GUIDELINES

Reporting late developments affecting the employment picture in the Electronic Industries

SURVEY SHOWS FIRMS FAVOR TWO-YEAR TECH TRAINING

Industrial employers apparently prefer to hire technicians with two years of college-level training, according to recent surveys.

A canvass of 133 firms by Manufacturing Chemist's Association disclosed that about 80% prefer to hire technicians with a formal two-year course over those with only on-the-job training. The second survey among 364 technician graduates of the New York City Community College, Brooklyn, showed that 95% of the five most recent classes are still in the field for which they were trained.

SOME GRADS FIND PROSPECTS GOOD DESPITE DOD CUTBACKS

Placement officials at Iowa State University report that graduating engineers are receiving fewer offers from aerospace and electronic recruiters. Gains in other engineering fields, however, are filling the gap and are pushing salary offers above the 1963 average.

Starting salaries offered ISU graduates in technical fields range in the $7300s in 1964, as against the 1963 average of $7116. A master's degree adds as much as $1500, a doctorate $4000 and up.

TOURS BEGUN TO INTEREST STUDENTS IN HOME STATE

Systems Engineering Laboratories, which currently has 50 engineers, and needs more, has taken a long-range step toward assuring itself of an adequate supply.

The company is inviting high school students with engineering interests to inspect its plant at Fort Lauderdale, Fla. The firm offers help with classroom projects, and it hopes to provide summer jobs.

FOR MORE INFORMATION . . . on opportunities described in this section fill out the convenient resume form, page 148.

ENGINEERS IN MANAGEMENT—A GROWING NEED PREDICTED

A Canadian railroad president suggests that efforts must be made to prepare more engineers for a greater role in industrial management. N. R. Crump, of Canadian Pacific Railway, reports that between 1951 and 1961 there was a growth of more than 20% in proportion of engineers in administrative and managerial functions. That proportion is now close to 30%.

This increase has come about by need of management to understand complexities of manufacturing processes, and the increasing reliance on statistical analysis for planning business operations. Engineers, says Mr. Crump, are well qualified here.

He contends, however, that engineers are not always ready in other respects to take on managing duties. Modern technology demands increasing specialization in education. The engineer's schooling in humanities, social and political sciences "have been somewhat neglected."

Referring to engineers' shortcomings, Mr. Crump said that they tend to be project-oriented rather than operations-oriented, and they are often inclined to be introverts. They appear to be more concerned with their departmental performance rather than that of the firm as a whole.

Mr. Crump recommends that employers provide broad experience and incentives in company operations in various departments for engineers who show some managerial promise.

Finally, Mr. Crump urges that the college engineering courses be extended to include more non-technical subjects which "go to make a well-rounded man."

NSF PREDICTS SHORTAGE OF 250,000 ENGINEERS BY '70

There may be as many as 250,000 more jobs for engineers and scientists as the decade approaches 1970 than there will be trained persons to fill them. The estimate is from a recent National Science Foundation report.

The report, "Scientists, Engineers and Technicians in the 1960's," observes that unless actions are taken to increase or more effectively use scientific and technical people, the manpower problems may continue and intensify during the next six years.

It appears that fewer than 765,000 newly trained scientists and engineers will become available to fill more than one million foreseen openings for them by 1970, the study reports. Demand for engineers is projected at more than 700,000—550,000 for increased needs and 165,000 for replacements.

COMPUTER TECHNIQUE 'TRACKS DOWN' SKILLS AND EXPERIENCES

RCA has developed a computer technique to produce a 'human resources inventory' for firms with a few hundred or many thousands of employees. The Personal Search Program, quick and economical, allows management to make most efficient use of available talents through detailed reports of the skills and experiences at its command.

World Radio History

Many systems makers, such as Sylvania (above), showing precision artwork for integrated circuit, have in-house circuits capabilities, and are usually major defense contractors.

Though not an R&D youngster, microcircuitry has spiraled in a few years into a fast growing market. Spurred on by aerospace/defense, microcircuits are about to be put to use in consumer and industrial products. High sales are seen by the 1970s. The question—"What will happen to discrete components?"—is evident

MICROCIRCUITS

By SIDNEY FELDMAN
Associate Editor
ELECTRONIC INDUSTRIES

MICROELECTRONICS TODAY

Percentage of yield continues to be a No. 1 problem in the microelectronic field. Higher yields mean lower unit costs with greater application possibilities.

There is a significant difference of opinion as to how higher yield can be achieved. One school of thought, advises putting as many circuits as possible on a single chip. This makes the unit circuits costs lower, but multiplies the problems of yield.

The second approach—is to keep the design on a unit circuit basis and concentrate on obtaining higher yields of the individual circuit.

These two philosophies are dominant at the moment. To bring EI readers up-to-date, we are publishing in this issue two articles which describe these programs in detail. "Cutting Systems Costs With Integrated Circuits" by Walt Weyler of Texas Instruments begins on page 70. The article, "Integrated Circuits Today" by Fairchild Semiconductor's G. L. Powers and R. J. Widler starts on page 75.

A review of microelectronics State-of-the-Art would not be complete without a report on what is happening in thin films. There is widespread feeling that the next major effort will be toward marrying the planar techniques with thin film techniques to obtain three-dimensional circuitry. Practical models are already in the laboratory stage, although commercial 3-D circuitry still seems some time away.

The State-of-the-Art in thin films is described in an article by General Electric's Arthur Meehan, titled, "Where Thin Films Are Today!" beginning on page 65.

It seems likely that their limited power handling capabilities and low range of inductances will continue to restrict applications of integrated circuits for some time. Discrete components, in improved designs, will still be called on to meet these needs. —B. F. O.

ALMOST OVERNIGHT, MICROCIRCUIT MAKERS surprised the "sophisticated" electronic industries by delivering usable production units — instead of apologies. Despite delayed and poor products in past, in recent months greater quantities of limited types of microcircuits are available, custom-made or off distributors' shelves.

Although microcircuit technology has been evolving for about two decades, suddenly a concept was transformed into marketable products. Last spring several concurrent developments thrust microcircuits into industrial and commercial markets.

Broader Lines Offered

A few manufacturers, who substantially mastered the basic materials and production techniques, began offering broader lines of microcircuits for use in industrial equipment. "Within two years integrated circuits will offer the cheapest approach to building most of the digital equipment that our civilization will use." This prediction was made by Dr. C. L. Hogan, vice president and general manager, Motorola Semiconductor Products. Markets may be broadened by price cuts of certain commercial-industrial microcircuit types.

In April, International Business Machines announced its System/360, the world's first generation of electronic computers using microcircuits operating at billionths-of-a-second speeds. To build these machines, IBM will bypass purchasing discrete compo-

World Radio History

Main assembly room for microcircuits at Fairchild Semiconductor, one of the 'Big Three' in a market that could top sales of $750 million by 1973.

SPUR COMPONENTS MARKET REAPPRAISAL

nents from outside vendors and make its own microcircuits.

Integration of microcircuits into products, equipments and systems may modify certain standard market patterns of the electronic industries. Despite some talk of a microcircuits "revolution," developments suggest a "reevaluation" of activities of discrete component functions, the nature of components and circuits businesses, corporate structures, and prospects of certain engineering, sales and management personnel.

In 1963 the sales of discrete components, modules, sub-assemblies, and microcircuits totaled about $3.6 billions by about 1,600 companies. This sum included merely $21.4 million worth of microcircuits—virtually all to defense agencies. Although microcircuit sales keep rising steadily, future market statistics are more to be conjectured than counted. The potential "market in 1975 for integrated circuits will be $400 million, rather than the $600 to $800 million reported in market surveys." So stated Dr. Robert N. Noyce, general manager of Fairchild Semiconductor, before the Financial Analysts Federation last April.

$750 Million By 1973

At the March 1964 IEEE Symposium on "Modular Magic," Texas Instruments' President Patrick E. Haggerty suggested "the total circuits market would increase from $3.6 billion in 1963 to a potential $5.8 billion in 1973, excluding the replacement parts market." He put "the actual integrated circuit market somewhere between $0.5 billion and $1 billion" and suggested "$750 million as a reasonable forecast by 1973."

Mr. Haggerty further assumed: "*If* this $750 million market develops, and *if* integrated circuits do the job, averaging half the cost of conventional circuitry replaced, then the potential $5.8 billion circuits market would decrease by $750 million. This would leave a $4.3 billion conventional circuitry market—roughly 20% over 1963's $3.6 billion."

Mr. Haggerty assumed microcircuits would cut government electronic equipment costs by about 7% in 1973. Such dollar shrinkage would force components makers to compensate for this 7% sales gap —simply to make up the difference.

However, he optimistically felt new components "should ensure both the replacement part of the market lost to integrated circuitry, plus a modest growth envisioned from 1963 through 1973." He attributed such growth to "wider applications of discrete active and passive components resulting from the availability in future of devices with higher current, voltage and frequency capabilities."

Limited Types

Microcircuits still are being produced in a limited number of types, not applicable universally. Hence these units will not soon or even eventually replace all electron tube or transistor circuits. Accordingly,

World Radio History

microcircuits will not *cut out* sales of all discrete components for tube and transistor circuits, but will *cut into* such sales and decrease profit margins.

Robert C. Sprague, chief executive of Sprague Electric Co., estimated the 1964 "military market for integrated circuits to be some 3.5 million active element groups (AEG's)." He defined these AEG's as tubes, transistors and related components, or elements of microcircuits. He figures the 1965 "military market for microcircuits will climb to 6 million AEG's, while industrial applications will be 5 million AEG's."

"By 1975," Sprague surmised, *"the industrial market will be five times the military market and the consumer market almost three times the military. Simultaneously, the transistor market will level off between 1966-1968, then decline appreciably to 1973."*

Astute electronic company officials long ago read this handwriting on the wall. Others, who will be more hard-pressed, may read the handwriting only when their backs will be to the wall. The message reads: microcircuits, like components, are processed materials. Components makers will become circuit creators. And circuit creators will become component makers. Hence, microcircuit makers either should *integrate upward* from materials into circuits, or *integrate downward* from circuits into materials.

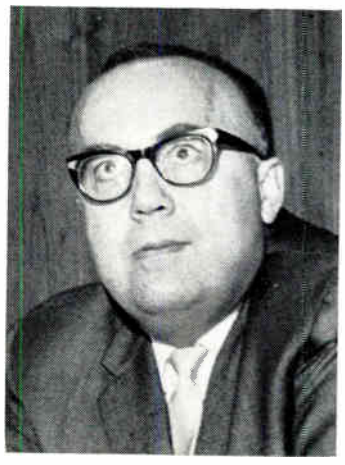
'World's Oldest'

Such reasoning led Corning Glass Works to buy the majority interest in Signetics, founded in 1961, which now is "the world's oldest exclusive integrated circuits maker" three-short-years-later. Corning-designed automatic equipment has improved microcircuit production in the Signetics plant at Raleigh, N. C. P. R. Mallory, a components firm active in materials and microcircuits, entered a joint venture with Xerox to supply microcircuit materials. And Union Carbide Corp. recently broadened from chemicals and metals into its first venture to produce semiconductors, integrated circuits and related devices.

The "Big Three" semiconductor fabricators who advanced their solid state technology into a microcircuits capability are: Fairchild Semiconductor, Motorola Semiconductor, and Texas Instruments. Other materials processors and components makers in the microcircuits field include IRC, CTS, Sprague, Mallory, Centralab and dozens more. Even as major semiconductor firms such as TI, Transitron, Motorola and Fairchild bypassed the electron tube business, so several firms have leap-frogged over the semiconductor field to get directly into microcircuits. Such virgin microelectronic firms, including Signetics, Molecular Science Corp., and General Micro Electronics Corp., were founded in the 1960's by using specialists spun-off from semiconductor operations.

Also competing in this market are equipment and systems makers with in-house components and microcircuit capabilities. Such firms generally are major defense contractors who may keep microcircuits business in-house for defense/aerospace systems. These firms include GE, RCA, IBM, ITT, Hughes, Sylvania, Raytheon and Westinghouse, among many others. Taking a leaf from IBM making System/360 microcircuits in-house, these companies also will

Patrick E. Haggerty, president of Texas Instruments, suggested "the total circuits market would increase from $3.6 billion in 1963 to a potential $5.8 billion in 1973, excluding the replacement parts market." Thinks microcircuits will cut government electronic equipment costs by 7% in 1973.



Dr. C. Lester Hogan, vice president and general manager, Motorola Semiconductor Products, predicts that "within two years integrated circuits will offer the cheapest approach to building most of the digital equipment that our civilization will use."

Dr. Robert N. Noyce, general manager of Fairchild Semiconductor, told Financial Analysts Federation that the potential "market in 1975 for integrated circuits will be $400 million, rather than the $600 to $800 million reported in market surveys."

World Radio History

MICROCIRCUIT MARKET (Continued)

seek captive microcircuit markets from their other divisions which make consumer and industrial items.

Wrong Starts

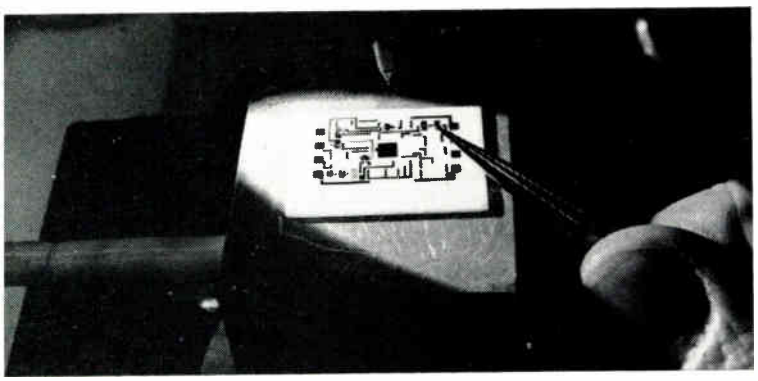
Though the smoke is far from cleared in the microcircuits field, some wrong starts are already known. P. R. Mallory apparently "bet" wrongly on the pelletized component and micromodule approach. It now must catch up, and plans to sell silicon microcircuits somewhere between 1964-65. RCA, with components, equipment and systems capabilities, has rerouted from micromodules into thin-films and other microcircuit approaches.

Certain defense/aerospace prime and major sub-contractors entered the field to obtain needed in-house microcircuit capability to attract or satisfy government contracts. Radiation, Inc., for example, funded its own integrated circuit $1 million facility to add "new dimension to systems reliability." Specialists in its new Physical Electronics Division are consulted by engineers in other Radiation divisions in applying silicon and thin-film technology to systems R&D from the start of a project. The firm's telemeters are the first to be converted from solid state into fully integrated circuit packages.

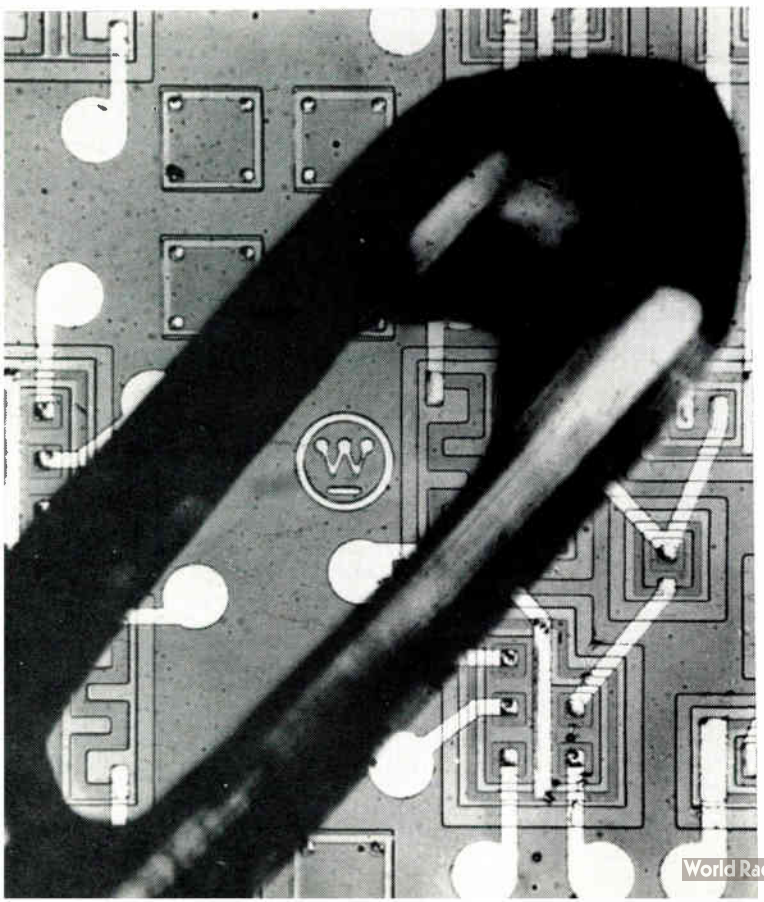
Other companies, such as Thompson Ramo Wooldridge, consolidated its microcircuits activities. Last March, solid state circuit development capabilities of TRW Semiconductors were transferred into the thin-film R&D and packaging activity of TRW Space Technology Laboratories to associate closely with STL's system and sub-system designers. STL will develop and produce special-performance microcircuits and sub-systems chiefly for military, space and other government requirements.

"This combined facility has strengthened TRW's R&D activities in integrated circuits, thin-films and hybrid microelectronic circuitry," says R. L. Ashley, marketing director, TRW Electronics. He notes there is no current outside microcircuits marketing activity "since all efforts are directed at in-house requirements. As commercially feasible products are developed in future, TRW intends to market them."

Some defense contractors entered microcircuitry to get needed in-house microcircuit capability to attract or satisfy government contracts. Radiation, Inc., funded its own facility to add "new dimension to system reliability." The firm, showing silicon and thin-film circuit for precision operational amplifier, was first to convert telemeters into fully integrated packages.



Defense contractors, including Westinghouse, follow trends in seeking captive microcircuit markets from their other divisions which make consumer and industrial items. This Molecular circuit shows tiny Westinghouse trademark (0.006") through needle eye.



Continues Researching

Another major sub-contractor, Collins Radio Co., continues researching thin-film and solid state physics, diffused semiconductor integrated circuits fabrication process development, pilot production circuit synthesis, and systems design. Collins finds thin-films suitable for several precision analog circuits, and diffused integrated circuits or hybrid processes better for other applications.

Texas Instruments supplies microcircuits for more than 100 defense programs. It is the largest microcircuit supplier to Autonetics/North American Aviation for improved Minuteman missiles. This is the biggest defense program committed to the microcircuit concept.

Many other primes and sub-contractors buy from microcircuit companies. Though Collins Radio makes microcircuits in-house, it also procures them from vendors. In summer 1963, Loral Electronics engineers compiled a "Micromin Digest" as a microcircuit techniques manual to aid them in design work. Included were more than 70 vendors, and characteristics of 186 microcircuit components. Signetics has advertised that its "integrated circuits capability"

World Radio History

was "thoroughly evaluated by more than 100 leading systems manufacturers. Results? Orders requiring a $5,000,000 plant expansion program."

Custom Business

Such developments tend to strengthen Motorola's contention that "the integrated circuits business will resolve itself into a custom business—with each equipment manufacturer designing his own circuits and submitting these to an integrated circuits manufacturer for delivery in production quantities."

Some competition among microcircuits suppliers has shifted from availability to price—chiefly for commercial units. In march 1960 the first defense-type semiconductor integrated circuit sold for $450. In May 1964 Fairchild Semiconductor offered a 3-input gate element for commercial use in quantities of 100 or more "as low as $2.55." These price cuts, ahead of schedule, were based partly on improved production yields at Fairchild which devotes 30% of its business to microcircuits. Competition heightens as Motorola also cuts some microcircuit prices as low as $1.95. Certain Signetics prices may drop to as low as $1.50. These cuts reflect competitive pressures and by-product benefits from production of military type microcircuits.

Even as leading microcircuits makers are assuming the traditional role of components makers, they also are using established distribution patterns. Fairchild, Motorola and Texas Instruments sell nationally through distributors, stocking reps and/or their own regional offices, and also take factory orders for custom units. Smaller microcircuits manufacturers and fabricators of microcircuits components also sell custom units directly, and through distributors.

Sells Directly

CTS Corp., for example, sells its cermet (ceramic-metal) microminiature modules directly, and uses sales reps in some areas. It relies heavily upon sales and design engineers because this product is quite technical. Other sources feel sales reps specializing in components will become obsolete unless they also become microcircuit specialists.

"We'll sell microcircuits as we now sell components and sub-assemblies," says Harvey E. Sampson, Jr., vice president of New York's Harvey Radio Co., distributors with about $8 million sales annually. He anticipates being franchised to distribute microcircuits for companies, including GE, RCA and Sprague, whose discrete components he now carries. "Microcircuits ultimately may help reduce our inventories of some 35,000 different shelf items," adds Sampson. "Yet we'll simultaneously stock discrete components alongside microcircuits for years."

Other marketing prospects and problems await electronic companies as the microcircuits era phases in. Additional markets are anticipated by makers of microcircuits processing equipment including laser welders (Hughes), electron welders (Hamilton-Zeiss), electron beam evaporators (Alloy Electronics), microelectronic unit testers sold by several firms, and even computers to be used in microcircuit design and manufacture. Rich rewards await the firm that finds a good way to inter-connect the tantalizing multiple hair-like leads of microcircuits.

Uncertainty, even anarchy, may endure for some time over complicated, inter-related microcircuit manufacturing process patents. Companies, including GE, TI, Fairchild and Lockheed Missiles & Space Co. now can license other microcircuit manufacturers at home and abroad. Philco, for example, first licensed Sprague as its second source of certain transistors. Now, Fairchild Semiconductor has licensed Philco, then Sperry, as its second and third sources of microcircuits.

Foreign Markets Astir

Overseas markets for microcircuits also are stirring. Fairchild plans to make and market microcircuits in Italy and England later this year. Microcircuits, used in IBM's new System/360 computers to be sold outside the United States, will be made in its French factory. IBM thus reduces shipping costs and increases manufacturing capability abroad.

(Continued on following page)

ELECTRONIC INDUSTRIES

MARKETING ASSISTANCE PROGRAM

CENSUS OF ELECTRONIC MANUFACTURERS NOW AVAILABLE!

AN IMPORTANT MARKETING TOOL ESSENTIAL TO EFFECTIVE MARKETING MANAGEMENT

Data on 6,000 electronic plant locations is now available through ELECTRONIC INDUSTRIES Census of Electronic Manufacturers. All of the Census data has recently been updated and includes—

Company Name & Address
Employment by Size Group
Number of Electronic Engineers & Production Workers
Plant Function
Percent of Plant Sales to the Military, Industrial and Consumer Markets
All Products Manufactured

This information is available in whole or part in IBM punchcard or printout form.

For further information contact your ELECTRONIC INDUSTRIES Regional Manager listed on page 155 or Edward G. Shaud, Jr., Marketing Manager, ELECTRONIC INDUSTRIES, Chestnut & 56th Streets, Philadelphia, Pennsylvania 19139.

World Radio History

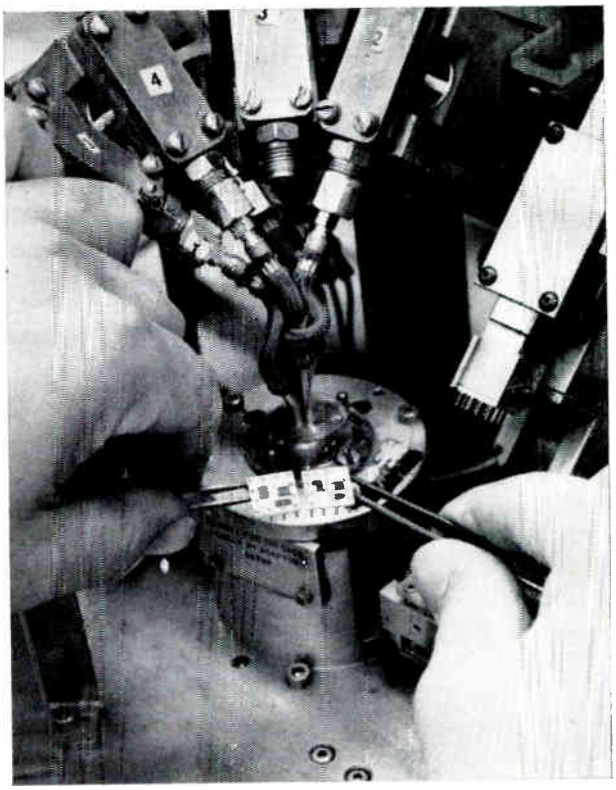
MICROCIRCUIT MARKET (Concluded)

Among the many West European electronic firms active and interested in microcircuits are: Ferranti (England); Philips (Holland); Siemens, and Grundig (licensed by Motorola) (Germany); CSF (France), several European ITT subsidiaries, and Ebauches (Swiss) which contemplates using microcircuits in wrist watches.

It remains to be seen whether U. S. microcircuit makers can discourage and undercut foreign competitors and expand U. S. markets abroad. This can be done, since U. S. companies have mastered technology to make lower-cost units in production quantities. However, the Europeans, and the Japanese too, insist upon developing their own capabilities for national defense reasons. Hence, licensing looks most likely over there.

Foreign and domestic microcircuit standards also remain to be resolved. U. S. microcircuit manufacturers generally would agree to standardize circuit sizes and packages, probably with 5N numbers. But microcircuit companies and their sponsors, the Defense Department, strongly resist standardizing microcircuit designs which would hamper flexibility. Last March, U. S. and foreign delegates to the International Electrotechnical Commission microcircuits group met in New York and agreed to develop "microelectronic definitions and terminology."

Even as microcircuits spark the next generation of electronic items, some sources speak of the forthcoming wave of "Technology X." This well might be circuits grown as bionic units.



IBM announced its System/360 in April—"the world's first generation of computers using microcircuits." The firm is by-passing purchase of discrete components from outside vendors and is making its own microcircuits. Photo shows modules half-inch square before and after trimming resistors. They are logic elements of 360.

• A REPRINT of ANY ARTICLE in this issue is available from ELECTRONIC INDUSTRIES Reader Service Department.

ON THE SPOT REPLATING

AN INNOVATION TO THE FIELD OF METAL PLATING has been contributed by Selectrons Ltd., 116 East 16th St., New York, N. Y. With this process virtually any metal that can be bath-plated can be applied. The rate of deposit is very high and thicknesses can be controlled within mils.

Process allows replating parts without dismantling equipment.

The new method, known as the Selectron Process, is an engineering technique for applying a controlled electrodeposit on a selected area. The localized deposit is achieved without having to immerse the entire component in a plating bath, and without excessive masking or stopping off. While the theory is that of electroplating, the practice is similar to arc welding.

Main working components of the Process are the special power pack, special electrolytes, and suitable stylus anodes. The cathode lead from the power pack is clamped to the work piece, and the graphite anode—wrapped with absorbent cotton and soaked in electrolyte—is rubbed across it. As current flows, the proper metal is deposited. It is even possible to deposit two or three metals simultaneously.

The Process should reduce rejects in printed circuits; stop costly loss of mismachined castings; and eliminate tedious dismantling of wiring harnesses to repair small components.

World Radio History

EDP INPUT SYSTEM TAKES STATEMENTS IN ENGLISH

A new input printing system with artificial intelligence called PRIN has been put into operation by TRG Incorporated. It virtually enables a project engineer to prepare input statements in ordinary English without the services of a programmer. The user merely observes a set of simple rules, understandable to a non-programmer.

According to Dr. Hanan Rubin, head of TRG's Computer Group, Melville, N. Y., preparation of input for a computer program, say a FORTRAN program, can be an onerous task. Cards of input data are unidentified and yet must be in predetermined order. Types and formats of input numbers and precise card columns in which they must be placed are rigidly fixed by the program.

"Free-form" input systems have been written which overcome some difficulties of computer input. TRG's PRIN is a powerful system, says Dr. Rubin, which overcomes all difficulties listed above as well as others.

COMMUNICATION CALLED KEY TO MANUFACTURING ADVANCES

More effective communication between laboratory and production line can speed up the advance of manufacturing technology, asserts an aerospace research engineer.

At a seminar on manufacturing research, Adolf Kastelowitz, of Republic Aviation Corp., said poor communication on the part of researchers often stalemates newly-developed manufacturing techniques.

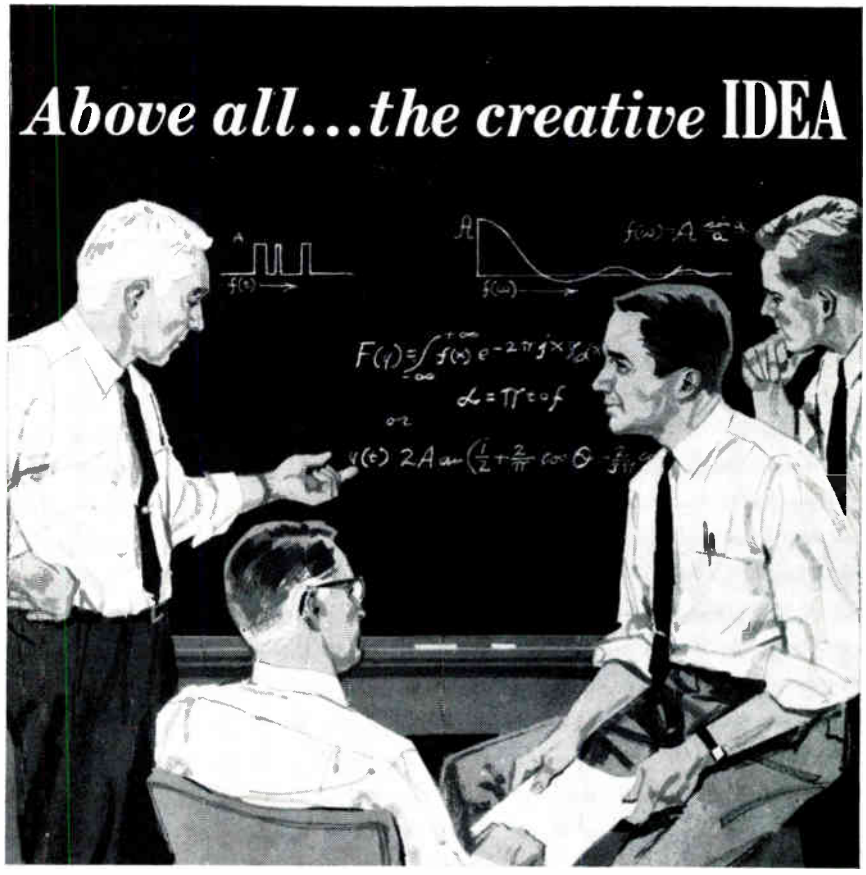
Research engineers, he said, must give greater consideration to the human relation factor if they are to overcome "traditional resistance to innovation."

ASA TO POLL FIRMS, SEEKING DOLLAR-SAVINGS FOR GOV'T.

American industry may hold the key to the government's saving valuable tax dollars in buying vital communications equipment, according to the Defense Communications Agency.

The DCA has authorized the American Standards Association to act as liaison with industry in establishing new engineering and installation standards.

ASA will solicit comments from segments of industry which are concerned with the standards of the Defense Communication System.



From the very beginning, Motorola has been an "engineer's company"—an organization where every consideration was secondary to the newest technological development. As a result, Motorola has attracted the type of engineer and scientist who is noted, not for his ability to conform—but to create.

In this intellectually rarified atmosphere, the challenges to an engineer are great—but, of course, the rewards are commensurate.

Motorola does *not* need "engineers" per se, but there is always an urgent need for really *good* engineers and scientists—men who are inspired by this dynamic environment rather than afraid of it—men who shun monotony and search for diversified projects. If you are such a man, we would like very much to talk with you.

LABORATORY MANAGER direct group of engineers and support personnel in complex R & D communications activities, airborne and mobile.
CRYSTAL ENGINEERS advanced R & D in Filter networks, frequency control, phase shift networks, involving quartz crystal applications.
SYSTEMS ENGINEERS advanced R & D in radio communications systems related to Two-way, portable, mobile and radio-telephone equipment.
CIRCUIT DESIGN ENGINEER advanced R & D related to circuit synthesis, Laplace transforms, magnetics and solid state Physics.
SYSTEM DESIGN analysis and synthesis of complete systems for operation in airborne, missile and spacecraft applications.
EQUIPMENT DESIGN high performance solid-state receivers, transmitters, and data processing equipment for radar, communications, command and control, tracking and telemetry.
FAMILIARITY WITH STATE-OF-THE-ART statistical communications theory, advanced signal processing techniques, solid state r. f. techniques, ultra-reliability, antenna systems, advanced structural and thermal designs.

Excellent opportunities also available in Phoenix, Ariz.

MR. W. H. HAUSMANN
Engineering Personnel Mgr. Dept. A
4545 Augusta Blvd., Chicago 51, Ill.

AN EQUAL OPPORTUNITY EMPLOYER

MOTOROLA inc.

World Radio History

LETTERS

to the Editor

"Best Chart in Years!"

Editor, ELECTRONIC INDUSTRIES:

I just received my August issue of ELECTRONIC INDUSTRIES. Upon going through the issue I discovered the best chart published in many years following page 68. The "Design Guide for Electronic-Optical Systems" is truly a "state-of-the-art" endeavor and fits your slogan printed on page 3.

The copy bound into my issue will be retained in my office for many years to come. In light of this, I would like to obtain another copy for our engineering office. Are additional copies available?

John E. Jackson
President
Jackson Electronics Co.
3628 St. Davids Rd.
Newtown Square, Pa.

Ed. note: Additional copies may be obtained by writing to Electronic Specialty Co., 4561 Colorado Blvd., Los Angeles, Calif. 90039

Good Article

Editor, ELECTRONIC INDUSTRIES:

Please send me a reprint of the article entitled "Capacitors: Today and Tomorrow" published in your June issue of Electronic Industries. Mr. Rudolf Graf is to be commended on writing such a clear, detailed and helpful article concerning electrolytic capacitors.

H. Brouwer
Electronic Design Section
Electrical Eng'g. Dept.
Lear Siegler, Inc.
4047 Eastern Avenue
Grand Rapids 8, Michigan

Editor, ELECTRONIC INDUSTRIES:

I wonder if you could spare seven (7) copies of "Capacitors: Today and Tomorrow" by Rudolf F. Graf in your June, 1964, issue. I would like to distribute these among our technicians. This is a very informative and well written article which I am sure will be of great value to them.

Robert Yorks
Project Engineer
Radio Astronomy Observatory
The University of Michigan
Ann Arbor, Michigan

Your June Issue . . .

Editor, ELECTRONIC INDUSTRIES:

I would like to take this opportunity to congratulate you on a fine publication, and in particular, the June, 1964, issue. As is customary, I circulate each issue to my men, however, in the case of the June issue, there are several articles which I want to retain in my files for future reference. Consequently, I would greatly appreciate reprints of the following articles. . . .

Carle A. Forster
Project Engineer
The Bunker-Ramo Corp.
8433 Fallbrook Ave.
Canoga Park, Calif.

Editor, ELECTRONIC INDUSTRIES:

I have just completed reading your ELECTRONIC INDUSTRIES "State of the Art Reference Issue" dated June, 1964, and found it to be most enlightening and informative. I would sincerely appreciate receiving reprints of the following articles. . . .

Arthur Allen, Supv. Engineer
Engineering and Test
General Electric Co.
King of Prussia Pk., Pa.

1) Cuts training time by 50% and more
2) Gives 70% greater retention
3) Increases comprehension average of 50%
4) Lets one instructor train a variety of skills
5) Makes new "hires" productive in less time

Videosonics Systems Division, Hughes Aircraft Company, P.O. Box 3310, Fullerton 21, Calif.

Name _____
Company _____
Address _____
City _____
Zone _____ State _____

For more information on Videosonic Training Systems of integrated audio-visual programs and display units please mail coupon today.

HUGHES
HUGHES AIRCRAFT COMPANY
VIDEOSONIC SYSTEMS DIVISION

World Radio History

ELECTRONIC INDUSTRIES

Advertisers — September 1964

This index is published as a convenience.
No liability is assumed for errors or omissions.

ELECTRONIC INDUSTRIES

REGIONAL SALES MANAGERS

Philadelphia 19139—56th & Chestnut Sts.
(Area Code 215) SHerwood 8-2000
JOSEPH DRUCKER
ROBERT Q. HINCKLE, Jr.

New York 17—100 East 42nd St.
(Area Code 212) OXford 7-3400
GERRY PELISSIER
HUGH ROBINSON

Boston (10), Mass.—10 High St.
(Area Code 617) LIberty 2-4460
ROBERT G. SMITH

Chicago (11)—540 N. Michigan Ave.
(Area Code 312) 467-9660
JOHN W. BERNHAROT
PHILIP T. CLARK

Cleveland (15)—601 Rockwell Ave.
(Area Code 216) SUperior 1-2860
ROBERT COBURN

Los Angeles (57)—198 S. Alvarado St.
(Area Code 213) DUnkirk 7-1271
GEORGE F. KELLEY
BURT UNOERWOOD

San Francisco (3)—1355 Market St.
(Area Code 415) 861-7107
DON MAY

Atlanta (9)—1776 Peachtree St. N.W.
(Area Code 415) 861-7107
JOHN W. SANGSTON

Dallas (6)—Meadows Bldg.
Expressway at Milton
(Area Code 214) EMerson 3-6426
HAROLD E. MOTT

EUROPEAN SALES OFFICES

London, S. W. (1)—67/68 Jermyn St.
St. James
MAX F. HOLSINGER

Dusseldorf—Huttenstrasse 17
Am Ernst-Reuter-Platz
MAX F. HOLSINGER

FAR EAST SALES OFFICE

Tokio Marunouchi, Japan
C. P. O. Box #1572, Room 814
Tel.: 211-3506-3509
Togin Bldg.
CLARENCE T. SAKAGUCHI

World Radio History

For OEM'S:
HIGH RELIABILITY,
LOW PRICED
INTEGRATED
FULL WAVE
BRIDGE
RECTIFIERS

IBR*

SILICON AVALANCHE
INTEGRATED BRIDGE RECTIFIERS

CIRCUIT TO CASE INSULATION OF 2000V MIN. PRESS FIT, TO-3 AND SINGLE STUD MOUNTINGS.

In a minimum size, electrically insulated package, the 1N4436 (250v BV_R min.) and 1N4437 (450v BV_R min.) use SAR* (Silicon Avalanche Rectifier) characteristics to control the avalanche voltage by causing it to occur across the entire junction area.

Thus, by eliminating junction perimeter destruction from transient overvoltage, decreased PRV safety factors may be used in design considerations.

Varo's IBR* devices feature 250v and 450v minimum avalanche voltages, 18 amps DC output current at 50°C (T_C) and 100 amp, one cycle current surge.

*TM Varo Inc.

OEM Prices:	1-99	100-999
1N4436	$4.15	$3.05
1N4437	$5.45	$4.00

Write for complete information or order from:

varo inc
SPECIAL PRODUCTS DIVISION
2201 WALNUT ST., GARLAND, TEXAS
AC 214 / BRoadway 6-6141
Circle 108 on Inquiry Card

SIGNAL ANALYSIS

By recording hf signals, then reproducing them in its stop-motion mode, a 75-lb. TV tape recorder makes it practical to study a wide variety of transients without need for loop recorders and readout devices, or related equipment. Technician (above) stops tape on Precision Instrument Co.'s PI-3V recorder to show recorded transient signal.

OCEAN FLOOR TRANSMITTER STILL SENDING IN 2ND YEAR

A transmitting and receiving device operating on the ocean floor off California for more than a year is still sending test signals, report officials of The Bendix Corp.

The equipment, a deep ocean transponder, was placed April 6, 1963, at a point 29 miles off Point Hueneme where the water is 6000 feet deep, according to David H. Brown, general manager of Bendix Pacific Division, North Hollywood. It has been interrogated at regular intervals. Responses are as strong now as when the unit was originally planted. The transponder can operate down to 20,000 feet.

EQUIPMENT, MATERIALS, PARTS & COMPONENTS

PHASE SHIFTERS
HIGH FREQUENCY—
—CONTINUOUS
0° thru 360°

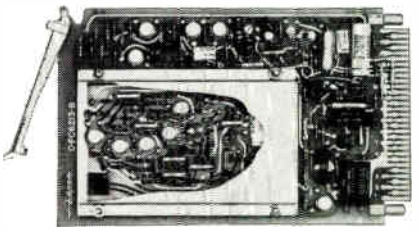
Variogon

NILSEN MFG. CO.
HAINES CITY, FLORIDA
(813) 422-1197 33844

7" TV test tube—$6.99. Tubes—6146—$2.95; 6211 (12AU7 equiv.) 39¢, 3 for $1. Germanium diodes, tested, equiv. 1N34, 1N60 etc., 30 for $1. Tophat silicon rectifiers, 750 MA—1000 piv 75¢. Transistors, tubes, resistors, condensers etc., bargain priced. Free catalog.
Arcturus Electronics, Dept. EI
502-22nd St., Union City, N. J. 07087.

AN APERTURE OF 0.1 MICROSECOND

SAMPLE and HOLD Amplifier Tracks with .01% Accuracy



The Adage Sample and Hold, Model SA3, is an operational amplifier with a switched storage element in the feedback loop. The unit is designed to follow rapidly moving waveforms and then, on digital command, to hold the sampled value accurately for relatively long periods.

Model SA3 will reach within .01% of final value in 10 microseconds, even for a full scale input step change. Output droop is less than .01% after one millisecond. The time uncertainty of switching from SAMPLE to HOLD is under 0.1 microsecond.

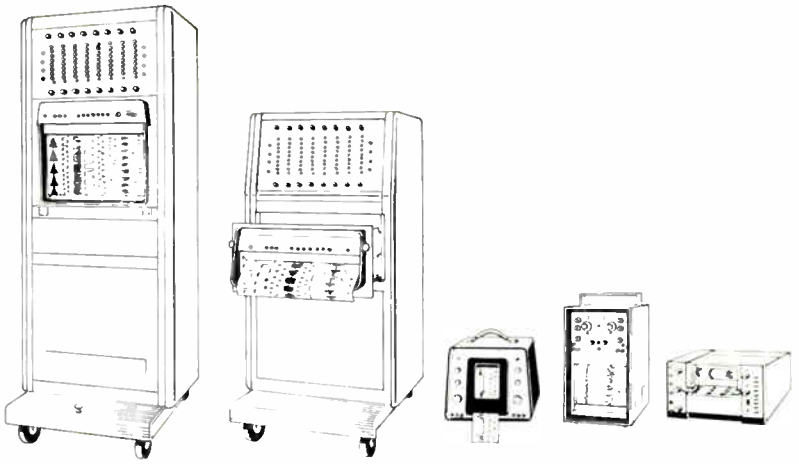
The amplifier, pictured above, is assembled on a standard Adage 5" x 8" Epoxy fiberglas plug-in etched circuit card and can be incorporated in any of the basic VOLDICON™ Analog-to-Digital Converters or Adage data systems. It embodies the same conservative, all solid-state design that characterizes Adage's line of analog/digital data processing and measuring equipment.

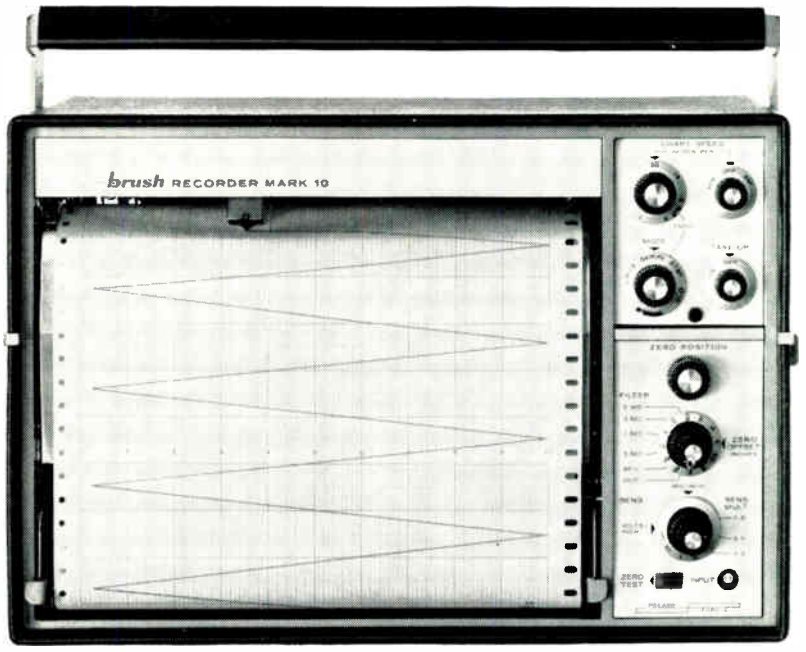
Adage INC
Main Office and Factory:
292 Main Street, Cambridge 42, Mass.
West Coast Plant:
1145 East Ash Avenue, Fullerton, California

Adage, Inc. welcomes employment inquiries from professional engineers.

Circle 109 on Inquiry Card

World Radio History





Mark 10
newest addition to
the Brush line

A new strip chart recorder that's all solid state...even the ink!

A solid capsule *is* the ink supply in this new 10″ servo-type recorder. Heated to flow freely from the pen . . . it dries instantly on contact with the paper. Modular electronic and mechanical assemblies simplify operation and maintenance. In addition, you have the complete flexibility of plug-in units. Check out these performance facts . . .

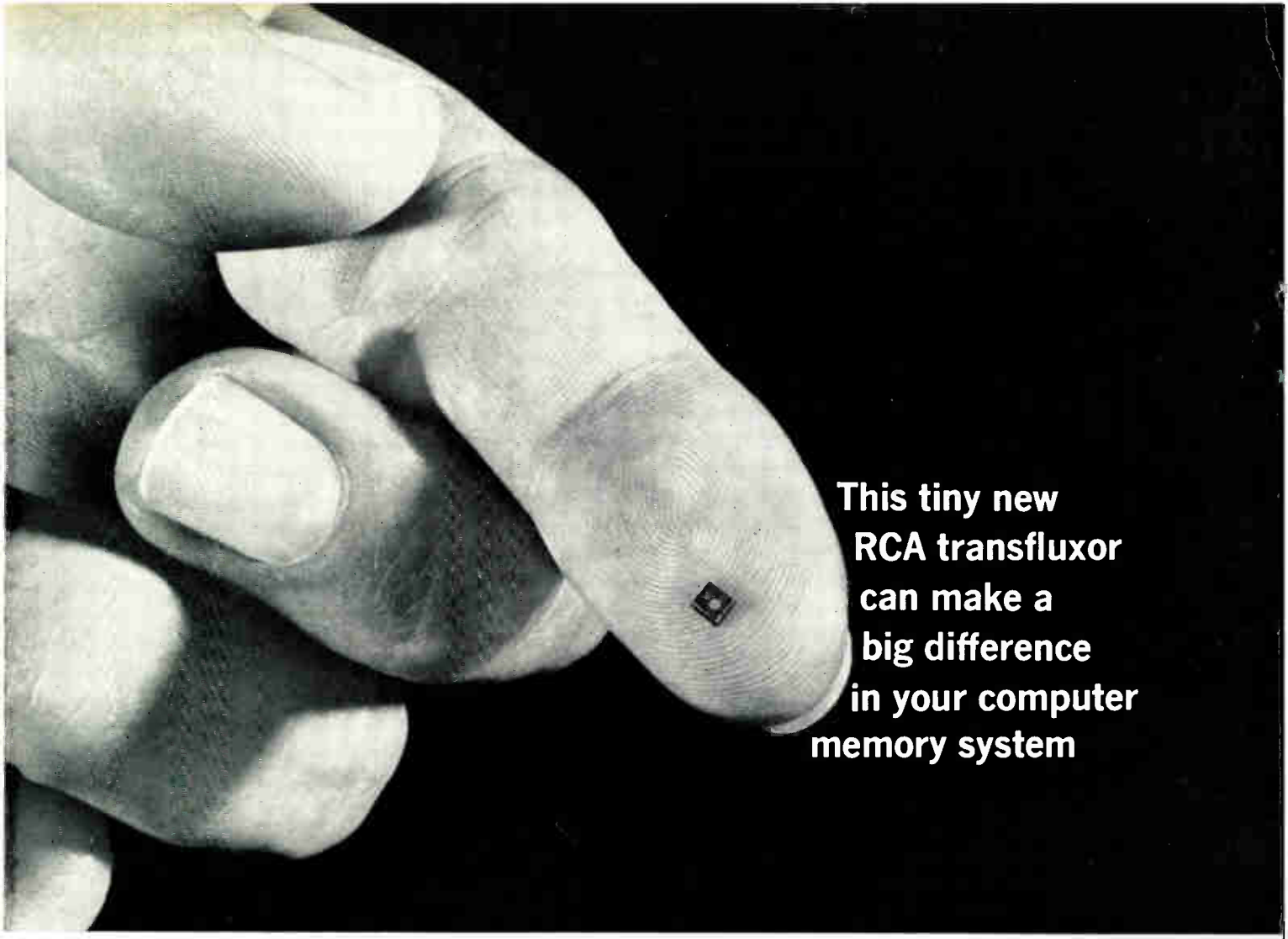
Full scale span of 5 mv to 200 volts in 15 steps
Zero positioned to within 0.1%
Zero suppression—up to 10 full scales
Selectable input signal filtering
Accepts common mode voltages up to 500 volts
140 db common mode rejection
1 megohm input impedance
10 chart speeds

Call Brush collect for complete details: 216-361-3315.

brush INSTRUMENTS
DIVISION OF CLEVITE 37TH AND PERKINS, CLEVELAND 14, OHIO

Circle 110 on Inquiry Card

World Radio History



NON-DESTRUCTIVE READOUT: stored data is retained as long as desired, despite multiple read-outs.

VERY HIGH SPEED: only 2 microseconds for a complete system read-write cycle.

WIDE TEMPERATURE CAPABILITY: operates at ambients from —55° to + 125°C without current compensation or temperature controls.

HIGH-DENSITY BIT STORAGE CAPACITY: 1000 bits per cubic inch.

New RCA 0154M5 ferrite transfluxors are ideal for compact, high-speed non-destructive-readout memories in missiles, supersonic aircraft and space vehicles. Each requires a blocking current of 1 amp, and set and read currents of only 600 ma, over the entire operating temperature range. Packaging density can be as high as 1000 bits per cubic inch.

These two-aperture high-speed transfluxors are available in bulk quantities, or as pre-assembled planes and stacks.

Each RCA transfluxor is individually tested on automatic test equipment to insure product consistency.

RCA transfluxors provide many advantages over conventional ferrite memory cores.

- Now you can save the time lost—and eliminate the extra electronics required by the regenerate operation.
- The memory can accept new information during the time that would otherwise be required by the regenerate operation.

These transfluxors *can* make a big difference in your designs. Get the facts. Call your nearest RCA Field Representative; or write, wire, or call RCA Electronic Components and Devices, Memory Products Operation, Section E-J-9, 64 "A" Street, Needham Heights 94, Mass.

RCA® **The Most Trusted Name in Electronics**

Circle 111 on Inquiry Card

World Radio History