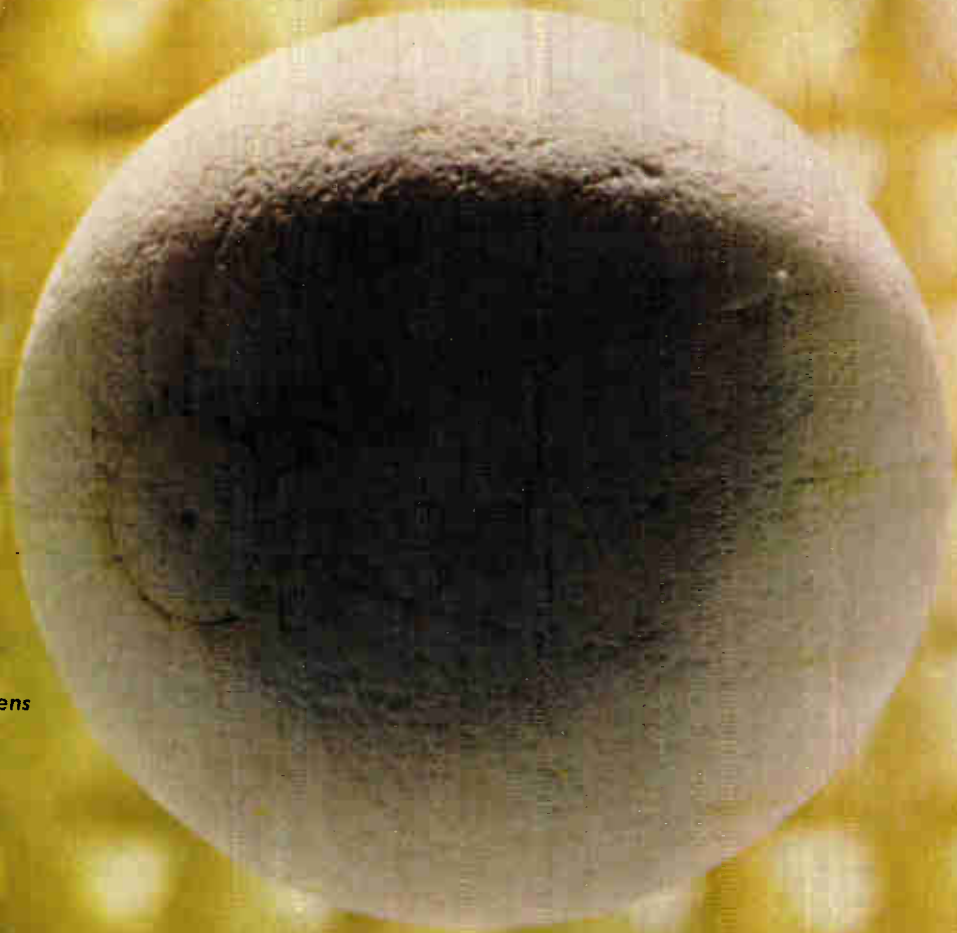
ELECTRONIC INDUSTRIES

THE STATE-OF-THE-ART MAGAZINE



Reflectivity Test for a Luneburg Lens

SELECTING ANTENNAS

Survey of h-v relays & steppers

FET digital circuitry

MAY 1965 Chilton Company

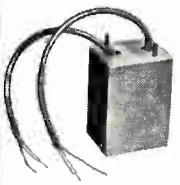
HI-FI

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 2×10^9. Primary 200K C.T. to within 0.1%. Secondary 50K.

HIGH POWERED 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.

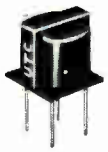
HYBRID TRANSFORMER

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.

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ELECTRONIC INDUSTRIES
The State-of-the-Art Magazine

SPOTLIGHT ON "ANTENNAS"

Dear Reader:

This month, we focus our editorial spotlight on the "State-of-the-Art" in Antenna Design. We are fortunate in having five of the most prominent experts to discuss the many aspects of the subject.

The design and use of antennas is a sophisticated art. This series will serve as a guide for those engineers who select antennas for a system, or are engaged in antenna design or applications. We chose to go to a panel of experts for this material because of the broad nature and complexity of the subject.

In order to develop this series of articles, EI editors first had to undertake an extensive preliminary study and survey program. Current literature was reviewed to see what had already been published. This was followed by person-to-person discussions with engineers in the field, and at technical meetings and conventions. Such programs require many months of planning.

With all of this completed, the next step was to select authors and arrange for manuscripts. Follow-up programs were initiated to be sure that texts would be available to meet printing schedules. Galley proofs had to be checked and rechecked with the authors. Adequate and informative illustrations had to be developed. Then came the problems of layout to make each article as attractively readable as possible. Finally, of course, is the actual printing and distribution of the magazine.

In general, the feature editorial material in any given issue is developed from three main sources. These include: texts directly solicited by us from recognized authorities in the field; staff studies, wherein all material is gathered, written, and presented by our own editors; and contributed articles that have been sent to us for review and evaluation by individual authors. In later letters we'll tell you more about what is involved in gathering feature material by each of these methods.

Sincerely,
The Editors

1965 EDITORIAL FEATURES

JUNE	• State-of-the-Art Reference Issue featuring Measurement & Test and Components
JULY	• RFI—State-of-the-Art • Plug & Jack Connectors Specification Chart • Solid State Photoconductors
AUGUST	• WESCON Show • Power Relays Specification Chart • Characteristics of Photovoltaic Diodes
SEPTEMBER	• State-of-the-Art in Solid State Devices • Potentiometers, part 1, Specification Chart • Phototransistors & Silicon PNPN Light-Activated Devices
OCTOBER	• Special Purpose Relays
NOVEMBER	• Microwave, 13th Annual Issue • Potentiometers, part 2, Specification Chart
DECEMBER	• Switches, part 1, Specification Chart • Computers, State-of-the-Art

ELECTRONIC INDUSTRIES
The STATE-OF-THE-ART Magazine

New Engineering Horizons

THE ELECTRONIC INDUSTRIES PRESENTED AN IMAGE of greater maturity and sophistication at the recent IEEE Show in New York. There were fewer "star attractions" in technology but more products designed to meet the specific needs of customers.

Solid state devices and systems attracted major attention. The applications of this technology blanket the electromagnetic spectrum from audio to microwaves. Vast amounts of electrical power can be controlled by low power signals. The wide use of SCR's has brought the electrical and electronic disciplines closer to each other. Broad use of solid state devices is also evident in the microwave field. And applications for integrated circuits in new fields could stimulate engineering employment.

Defense and aerospace skills are being turned toward industrial and commercial applications. Problems in railroad, air transport, utilities and banking are being studied by management-engineering teams from electronic and aerospace companies. They are applying their problem-solving experience in three areas:

1. Systems Concepts.
2. Central Computer Applications.
3. Communications for data acquisition, processing, control, storage and dissemination.

Electronic companies continue to diversify their activities, through mergers and acquisitions. Some firms have entered new fields. Others have broadened their present in-house activities. For example, Amphenol-Borg Electronics Corp., a pioneer in components, is introducing new lines of TV service instruments and citizens' band transceivers. Westinghouse is increasing its staff, facilities and activities in oceanography. By 1975 it expects oceanography may represent 10% of its sales which now exceed $2.0 billions annually.

As electronic technologies are applied widely to commerce and industry, engineers play new roles. Broader horizons are being urged upon engineers by Frederick R. Kappel, Chairman of the Board of American Telephone and Telegraph Co. He says, "we are coming to understand that engineering and science are today interdependent and interactive. The engineer's responsibility to make investment productive is becoming more critical every day of the year." Mr. Kappel also says, "the engineer today has a tremendous political obligation . . . the influence of science upon government is manifest." He asks, "electronic and electrical engineers to stand up and be counted, and take their full part in the public debate."

As times and technology change, engineering and management techniques must keep pace. Dr. J. Herbert Hollomon, Assistant Secretary of Commerce for Science and Technology, expresses the Government's new outlook on technology: "Until recently, we supported only the basic science aimed at advancing the State-of-the-Art. We did not support, in our engineering, the skills to make the fullest use of new knowledge."

ELECTRONIC INDUSTRIES continues its policy of publishing State-of-the-Art developments and interpreting their significance. We believe the engineer of the future will be a "total engineer," versed in technology and skilled in business know-how. He will be more alert and active in business and government—as well as in technology.

Bernard F. Osbahr

May 1965, Vol. 24, No. 5

ELECTRONIC INDUSTRIES

The STATE-OF-THE-ART* Magazine

COVER: This Luneberg lens, manufactured by Armstrong Cork Co., has a radially-symmetrical index of refraction with a value of unity at the surface so that it is matched to space and provides reflection-free performance. Story on page 87.

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

BPA AMERICAN BUSINESS PRESS, INC.

ELECTRONIC INDUSTRIES

HIGHLIGHTS

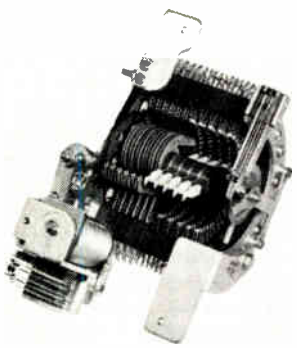
Aperture Antennas

CONSIDERATIONS IN SELECTING ANTENNAS 70

There are several key factors to be considered in selecting an antenna: its purpose, its characteristic, its design, and the service for which it will be used. This article reviews the influence of each. Individual antennas are discussed in the articles that follow this.

LINEAR ANTENNAS 75

The category of linear antennas includes: dipole arrays, cylindrical dipoles, biconical dipoles, discones, folded dipoles, sleeve dipoles, monopoles, and loops. To better understand these antennas, essential formulas involved in antenna theory are given, along with important characteristics.



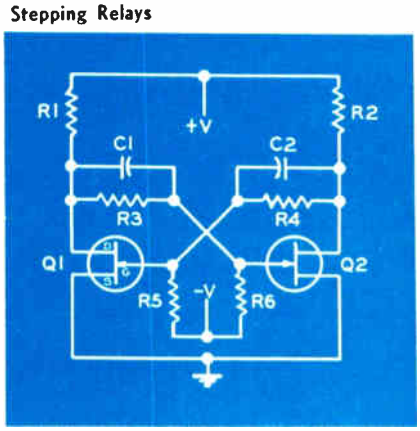
Stepping Relays

APERTURE ANTENNAS 82

Aperture antennas are loosely broken down to reflector antennas, horns, lenses, surface and leaky wave antennas. Of this group, the reflector antenna can be considered the work horse of the antenna industry. The pertinent information about these and other antennas is given here.

STEPPING RELAYS & HIGH VOLTAGE RELAYS 47

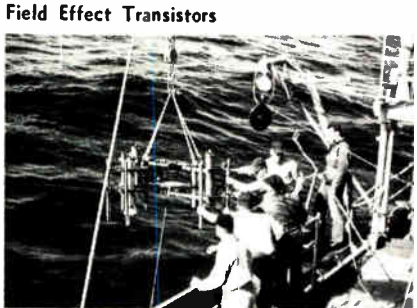
Part 2 of E.I.'s relay specifying guide surveys important characteristics of the various relays offered specifically for stepping and high voltage applications.



Field Effect Transistors

USING FIELD EFFECT TRANSISTORS FOR DIGITAL CIRCUITS 95

Due to improvements in the dynamic characteristics of Field Effect Transistors they can now be used extensively in digital circuits. But, certain design criteria must be observed. This article presents some of these criteria and shows how a typical 3-stage counter can be logically designed.

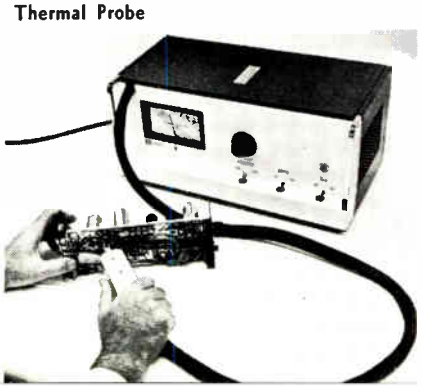


Oceanography

OCEANOGRAPHY—CHALLENGE FOR DESIGNERS 122

Development of oceanography depends largely on Federal cash, Congressional understanding, industrial faith, relation to defense—and how the seas stack up as a repository of natural resources.

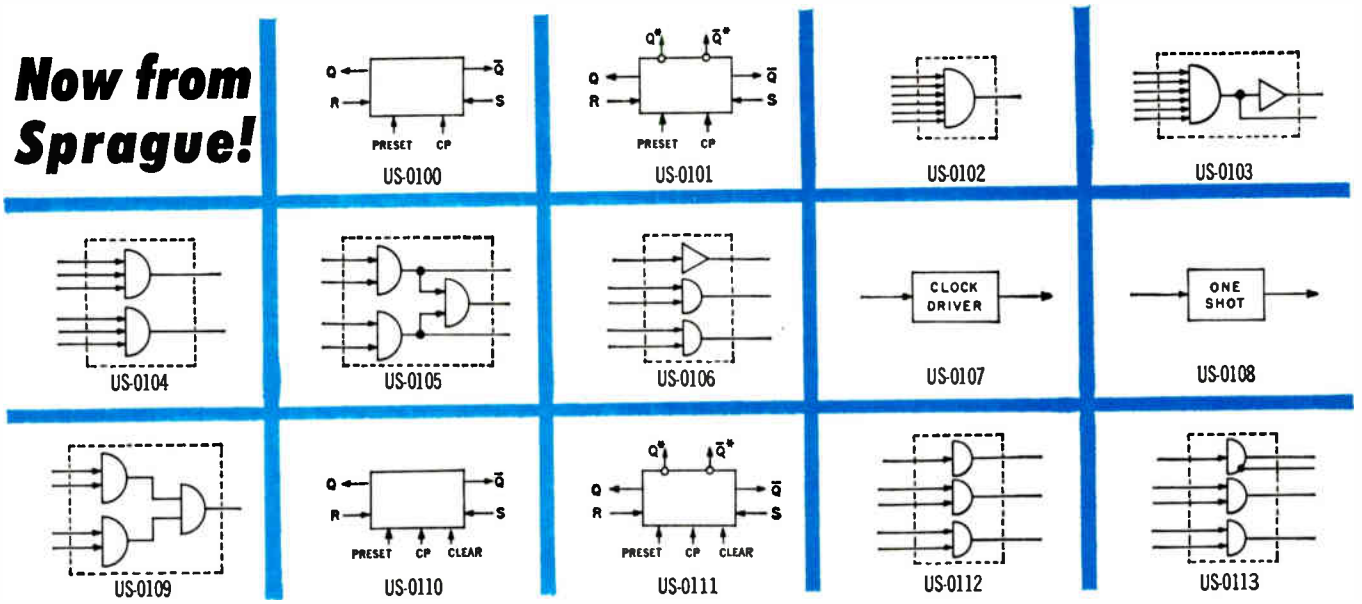
Thermal Probe



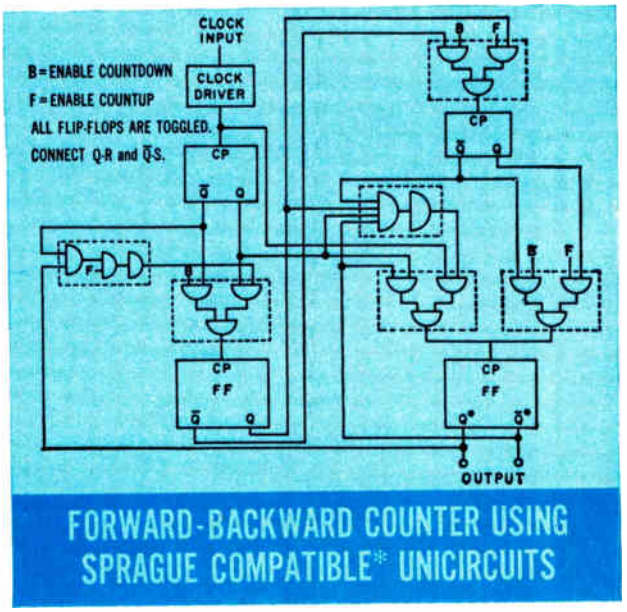
PROBE SPEEDS ENVIRONMENTAL TESTING 114

Convenient substitute for the usual temperature chamber in environmental testing of circuit components saves time and expense.

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



14 low-power RCTL integrated circuits capable of performing up to 95% of the functions of a complete digital system



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high-gain/performance amplifiers for low-level, wideband systems at lowest cost. Completely transistorized, these state-of-the-art amplifiers use field-effect transistors in place of mechanical choppers to achieve lowest drift rate, freedom from microphonics and maximum reliability. Gain range to 3000 and a continuously adjustable 10-turn vernier control are provided as standard features. Two differential models with ±10 ma or ±100 ma output current from a low impedance can drive long lines, A to D converters, multiplexers, galvanometers or tape recorders. Transfer characteristic is optimized to provide wide frequency response with minimum overshoot, fastest settling and overload recovery times, and minimum phase shift. Common mode rejection is greater than 120 db with up to ±300 volts dc or peak ac common mode voltage.

All models have built-in power supplies, feature drift less than 1 μV per week, wideband noise less than 4 μV rms, linearity better than 0.02%. Can be used either separately or in the same rack module with Model 1155 Universal Signal Conditioning Unit or Model 890 Electronic Filter to form complete, isolated signal conditioning channels.

Model 885-135 Differential Amplifier to drive multiplexers, tape recorders and A to D converters.

GAIN RANGE: 1 to 3000
INPUT RESISTANCE: 100 megohms
BANDWIDTH: dc to 10 kc
OUTPUT: ±5 volts at ±10 ma
DRIFT: ±1 μV for 40 hours
TEMP. COEFF: ±0.2 μV/°F
NOISE: 2 μV rms

Model 885-235 Differential Amplifier to drive data systems, long lines and galvanometers.

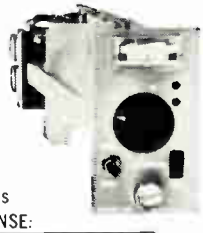
GAIN RANGE: 3 to 3000
INPUT RESISTANCE: 100 megohms
BANDWIDTH: dc to 10 kc
OUTPUT: ±10 volts at ±100 ma
DRIFT: ±1 μV for 40 hours
TEMP. COEFF: ±0.2 μV/°F
NOISE: 2 μV rms

Model 1155 Universal Signal Conditioning Unit

Uses plug-in circuit cards to supply excitation or bias, attenuation, circuit completion, balancing, filtering and calibration. Used with low-level or high level signals from thermocouples, strain gages, resistance temperature sensors, thermistors, potentiometers and voltage sources. Can function separately or in same rack module with Models 884 or 885 Amplifiers or Model 890 Filter to provide complete conditioning, calibration and normalizing of transducer signals.

Model 141-102 Wideband DC Utility Amplifier to drive galvanometers and fulfill wideband dc amplifier requirements.

GAIN RANGE: 1 to 25
INPUT RESISTANCE: >10 megohms
OUTPUT: ±10 ma at ±10 volts
COMMON MODE REJECTION: >60 db at all gain settings



FREQUENCY RESPONSE:

RESPONSE:	±½%	±3.0%	−3 db point
FIXED GAIN POS:	dc to 20 kc	dc to 100 kc	500 kc

Model 120 Nanovolt Amplifier gives you high-gain/low-noise amplification for seismic transducer signals, cryogenic studies, thermocouple or strain gage signals.

GAIN RANGE: 200 to 1,000,000
BANDWIDTH: dc to 100 cps
NOISE: 0.05 μV rms
INPUT RESISTANCE: 1 megohm
OUTPUT LEVEL: 0 to ±5 volts at ±5 ma

Model 121Z Nanovoltmeter provides 0.1 μV full scale bridge balance detector or thermocouple indicator for standards and calibration work, in the field and in laboratories.

FULL SCALE RANGES: ±0.1 μV to ±100 mv
INPUT RESISTANCE: 1 megohm
ZERO SUPPRESSION: ±0.5 μV to ±5 mv
AMPLIFIER OUTPUT: Gain 30 to 3 million, delivers ±5 volts at ±5 ma
Overload Indicator

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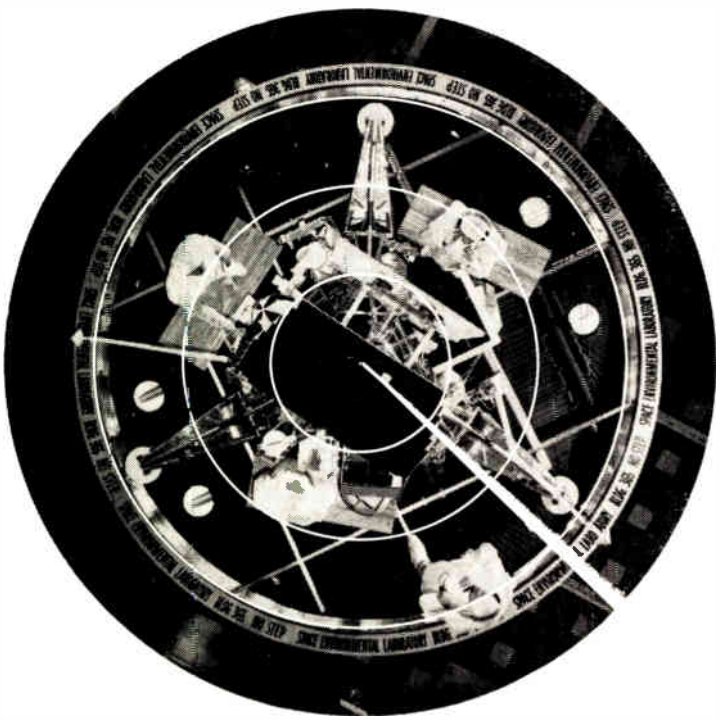
ELECTRONIC INDUSTRIES RADARSCOPE

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



MOON SURVEYOR

Engineers at Hughes Aircraft Co. prepare to raise Surveyor spacecraft into a chamber simulating the moon's temperatures and vacuum. Solar cell (center) will supply power for electronic equipment. Surveyor will transmit back to earth TV pictures of the moon's crust and also send back other pertinent information.

VARIABLE GAIN NETWORKS are made of magnetic material etched into the form of toroids. They may be wired to produce an ac signal which is proportional to a dc signal. A property of this device is that it will accept a momentary control signal and produce an output signal which is proportional to it, even after the control signal is removed. This accounts for its "variable gain." LFE Electronics received a contract from AFSC, Wright-Patterson AFB for these integrated magnetic variable gain networks. These devices will be useful in systems for pattern recognition.

BREAKDOWN OF GASES by lasers has been the subject of research by two University of Rochester researchers. Gases can be ionized by photons of sufficient energy to knock electrons out of their orbits around a nucleus. The research team learned that up to 14 photons of smaller energies can "stack up" inside an atom and produce enough energy to kick out an electron. Prior to this work, no serious consideration was given to the possibility of more than one photon ionizing a gas. Gases such as argon and neon were used.

EARTH EXPLORATION by radar will be tried by Ohio State University engineers and scientists from the electrical engineering and geology departments. Tests will be made, using several frequencies, to learn if radar responses will vary according to the types of surface materials, various atmospheric conditions and moisture content of the surface. If successful, it could be used to explore the moon and planets before manned landings are tried. Work is being done for NASA.

SIGNAL DISTORTION in satellite communications will be reduced by a new method announced by Sylvania Electric Products Inc. Messages sent from several ground stations would be timed to reach the satellite in rapid, synchronized sequence. Thus, the normal distortion that occurs when two or more signals are transmitted at once would be overcome. The method would permit weak ground stations to share the satellite with more powerful transmitters. It could result in fewer satellites which would handle increased message loads.

A LASER MATERIAL that automatically generates very sharp and powerful individual pulses of laser light has been produced by Westinghouse researchers. Such laser emission is known as giant-spike operation. It greatly increases the peak power of a laser beam. Giant-spike operation usually requires complicated optical apparatus placed outside the laser itself; but, with the new glass laser material, giant spikes of laser energy can be produced within the laser itself.

HOT GAS SOLDERING using heated hydrogen gas for integrated circuits has been developed by Sperry Gyroscope Co. Sperry plates solder onto sub-assembly cards in a pre-soldering operation. Next, a microelectronic network is placed on the card. The card is then moved past the hot gas which melts the solder without damaging the card or circuit. The gas unit can automatically solder 20,000 joints per day, with possibilities of 500,000.

A STEREO SIGNAL, transmitted from earth, received by a satellite orbiting over 5,000 miles above earth, and re-transmitted back to earth, maintains its quality. This was proven in a recent test involving Collins Radio Co. stereo equipment at NASA's Goddard Space Flight Center. Purpose of the test was to gather further proof that the American method of stereo broadcasting, known as "Pilot-Tone," should be adopted as the standard of the world. Results of the test will be presented to the Commission Consultatif International de Radio which is composed of representatives of the world's major countries.

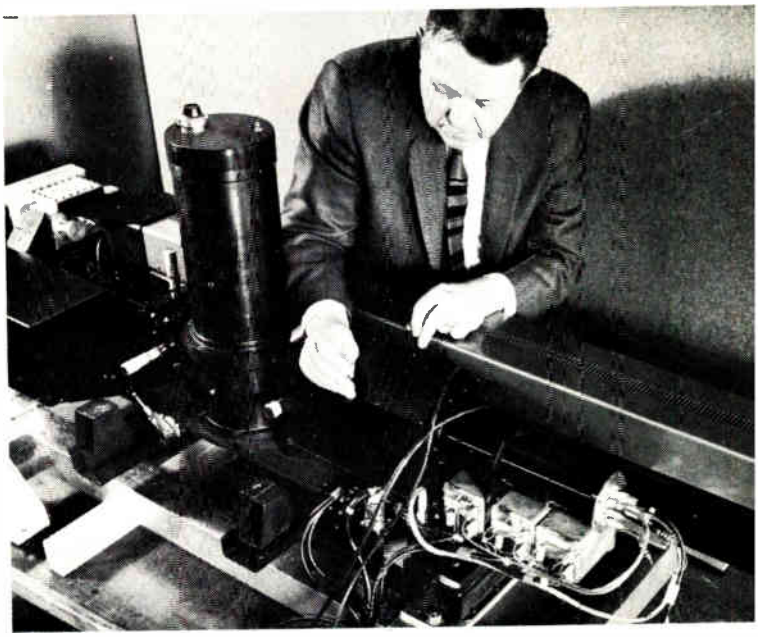
A GATED AMPLIFIER for use with high-speed variable store memory systems has been developed at Bell Telephone Labs. It can amplify ±5 mv, 35 nsec information signals appearing 15 nsec after decay of a write disturbance burst 40 times the signal amplitude. A 5 to 1 signal-to-disturbance ratio is achieved at the amplifier output. Normal memory amplifiers need time to recover from this write energy. The gated amplifier eleminates the need for this recovery time. It does this by blocking the write energy and amplifying only the signal.

SUPERCONDUCTING GENERATOR capable of 8000 watts of alternating electric power has been developed by Avco-Everett Research Laboratory. The experimental generator is expected to lead to lightweight, compact, highly mobile power units for a variety of military needs. The generator is a 3-phase, 4-pole alternator, runs at 400 CPS and operates continuously at 12,000 RPM by any prime mover

SELENIUM ALLOY is being used in new color pick-up tubes being made by RCA for broadcast use. Selenium is far more sensitive to light than materials now being used in vidicon tubes. But, up to now it has been unstable at temperatures found in TV cameras. This alloy solves the problem. Truer colors and faster response time will be possible.

SIGN OF THE TIMES

Replacing the salesman's heavy sample case is this small jewel box containing samples of microwave diodes and other electronic devices. Elliot March, sales mgr. for Raytheon Co.'s Micro State Electronics subsidiary of Murray Hill, N. J. also carries as part of his kit a magnifying glass and a pair of tweezers.



TERRAIN PROFILER USES LASER

Homer Jensen, of Aero Service division of Litton Industries, examines laser altimeter portion of new laser profiler. Instrument, offered for airborne mapping, uses a 50-mw CW laser beam. Telescope by Mr. Jensen's right hand transmits the beam from the plane to the surface below and receives the reflected beam.

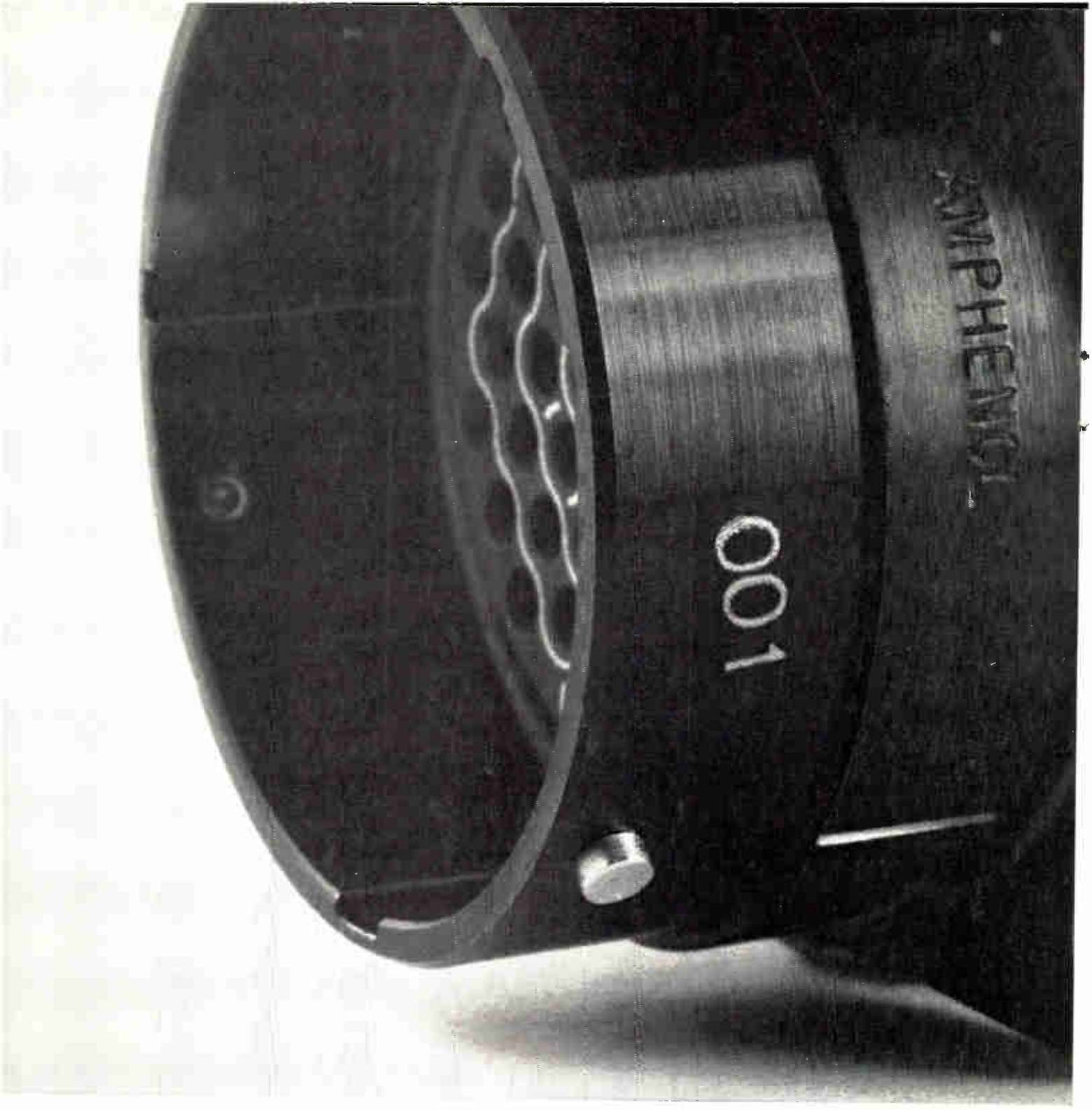
MICROELECTRONICS

LOWER PRICED INTEGRATED CIRCUITS are the result of a new epoxy encapsulation process and packaging of devices in Hong Kong. Fairchild Semiconductor has reduced the cost of its 923 binary flip-flop to $2.70 each in quantities of 100 and predicts a price of 98 cents for this device in a few months as production orders increase. The epoxy encapsulation replaces the TO-5 metal can previously used and performs satisfactorily over a temperature range from 15°C to 55°C.

CLOSE DENSITY PACKAGING of microcircuits —particularly flat-packs—has brought the power dissipation problem to a level where serious effort is going into possible solutions. Thermally conductive strips and thermoelectric devices are the principal approaches.

MICROELECTRONIC CIRCUIT which replaces 21 separate flip flops, in one microscopic wafer 70/1000 in. long and 60/1000 in. wide, has been announced by General Instrument Corp. The computer microcircuit, known as the "21-bit shift register," contains 110 transistors and 48 resistors built into a silicon wafer.

SAPPHIRE SUBSTRATES combine the good thermal conductivity of alumina with the smooth surface features of glass. They also show a low radiation sensitivity. For these reasons more and more thin film components and integrated circuits are now being produced on sapphire substrates. The substrates, manufactured by Insaco, Inc., Quakertown, Pa., can be made to almost any size, orientation, or surface finish specification.



Now Amphenol introduces connector traceability —by the number

The "001" tells you this Amphenol 48 Series connector was assembled with a group of 1,472 other MIL-C-26500 connectors on Thursday, December 10, 1964.

All 48 Series connectors assembled on one day in the same production run are stamped with an identical number. We call it a Specific Control Number, or SCN. It's your reference

Circle 5 on Inquiry Card

to a *complete recorded* history of the part and all others made during that particular production run.

This Amphenol SCN system assures complete traceability of every component part in every stage of production. We can start with a single component and trace up to the complete connector, or trace back from a connector to a part.

If any defective condition should be traced to "001", all that's needed is to check the connectors marked "001". It's a real time saver if you're dealing with thousands of connectors in a jet aircraft, missile, submarine, or computer.

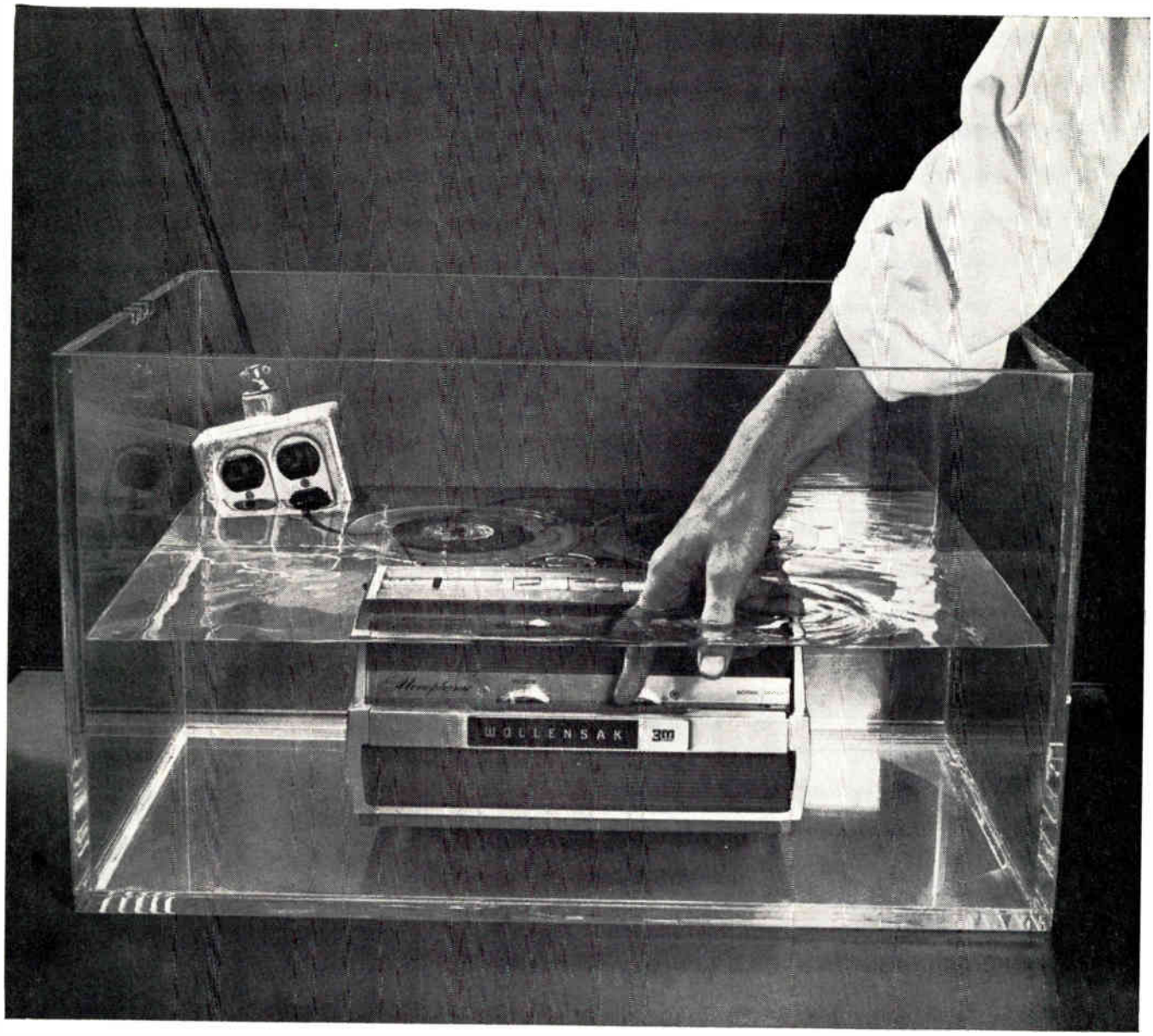
We can give you a ready portfolio of traceability information when you need it—during design, during breadboarding, or during test model inspection.

Amphenol's is the only *documented* reliability you can get with a connector. So why settle for somebody else's confidence limits? Ask your Amphenol Sales Engineer. Or write the *Amphenol Connector Division, 1830 South 54th Avenue, Chicago, Illinois 60650.*

Amphenol® CONNECTOR DIVISION

AMPHENOL-BORG ELECTRONICS CORPORATION

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



WHAT IS A TAPE RECORDER DOING IN FC-77 COOLANT?

Playing!

This traffic-stopping demonstration of the completely inert dependability of FC-77 coolant has been featured at several national electronic trade shows. An ordinary "right-out-of-stock" tape recorder is lowered into a tankful of FC-77, plugged into an electrical outlet and a hand reaches in and pushes the button to start a practically continuous concert that plays during the show.

All this time, recorder parts of steel, copper, chrome, plastic, rubber, elastomers, glass, nylon, adhesives, as well as recording tapes are directly immersed in FC-77 coolant. Nevertheless the recorder plays on. When at the end of a show, the player is removed from the tank none of its components are affected. How's that for "inertness"!

All members of 3M's fluorochemical coolant family have this exceptional compatibility with most materials (even at temperatures above the maximum permissible with other dielectric coolants). This "easy-to-get-along-with" coolant, incorporated into your system can bring about better reliability. *Want more?* These coolants have wide liquid ranges, excellent electrical properties, thermal and chemical stability, are non-flammable, non-corrosive, non-toxic. Write and ask about them, particularly our new, economical FC-77. 3M Company, Chemical Division, Dept. KCQ-55, St. Paul, Minn. 55119.

Chemical Division 3M COMPANY

Out in Front! New KNOBPOT® Senior Precision Potentiometer with ±0.1% Dial Accuracy

The acclaim and immediate acceptance which greeted Bourns' original KNOBPOT, a major advance in the state-of-the-art, have led to the development of a "Senior" version, to provide higher resistance values and increased accuracy. You can see in the photo below that this new unit saves you nearly all the back-panel space consumed by the bulky conventional type. That's because it's a potentiometer, knob and turns-counting dial all in one, mounting entirely in front of the panel.

KNOBPOT Sr., Model 3640, a companion unit to the revolutionary Bourns KNOBPOT Model 3600, gives you a bonus in accuracy, resolution, and power, too. The whole unit... including the integral turns-counting dial... is more accurate than the best competitive potentiometer/dial combination.

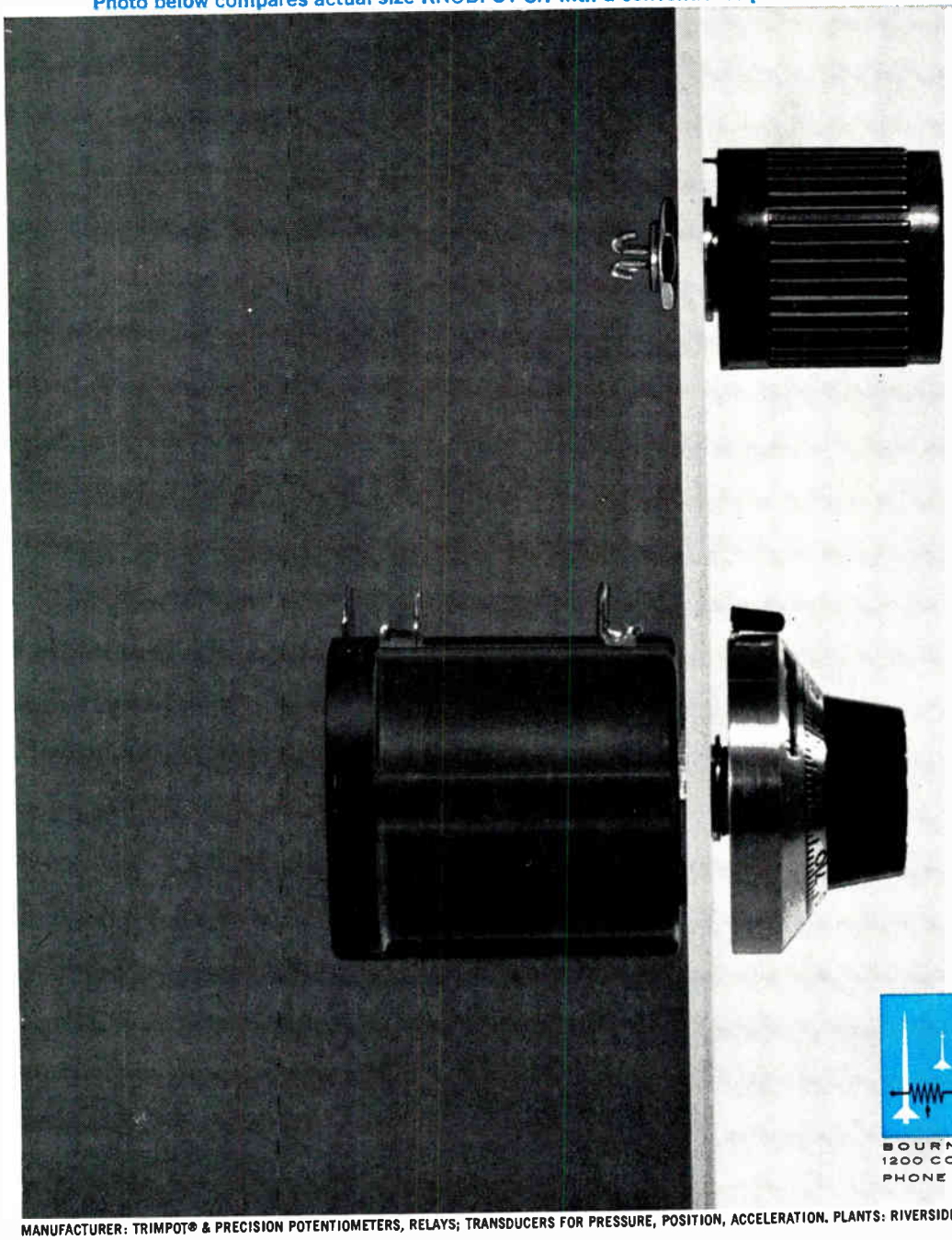
In your production, KNOBPOT Sr. potentiometers save you time and trouble. For example, they put an end to do-it-yourself installation. Phasing is done for you—with extreme accuracy—at the Bourns plant. No separate dial to attach, no complicated mounting procedure. Just drill two holes, put the unit on the panel and tighten the nut. That's the whole installation!

Most important of all benefits, however, is the name on the package! It means that the product has undergone 100% in-process and final inspections as well as the double-check of Bourns Reliability Assurance Program. You can be "out in front" in more ways than one if you specify the Model 3640, KNOBPOT Sr. potentiometer. Write today for complete technical data.

Standard Resistances: 500Ω to 250K
Dial Accuracy (correlation of dial reading to voltage output): ±0.1% max.
Repeatability (ability to return to a previously established setting): ±0.05%
Resolution: 0.03 to 0.006%
Power Rating: 2.5 watts at 25°C
Max. Operating Temp.: 125°C
Dimensions (in front of panel): only 1½" long x 1¼" dia.

ONE-HALF ACTUAL SIZE

Photo below compares actual-size KNOBPOT Sr. with a conventional potentiometer and separate dial package.



BOURNS

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

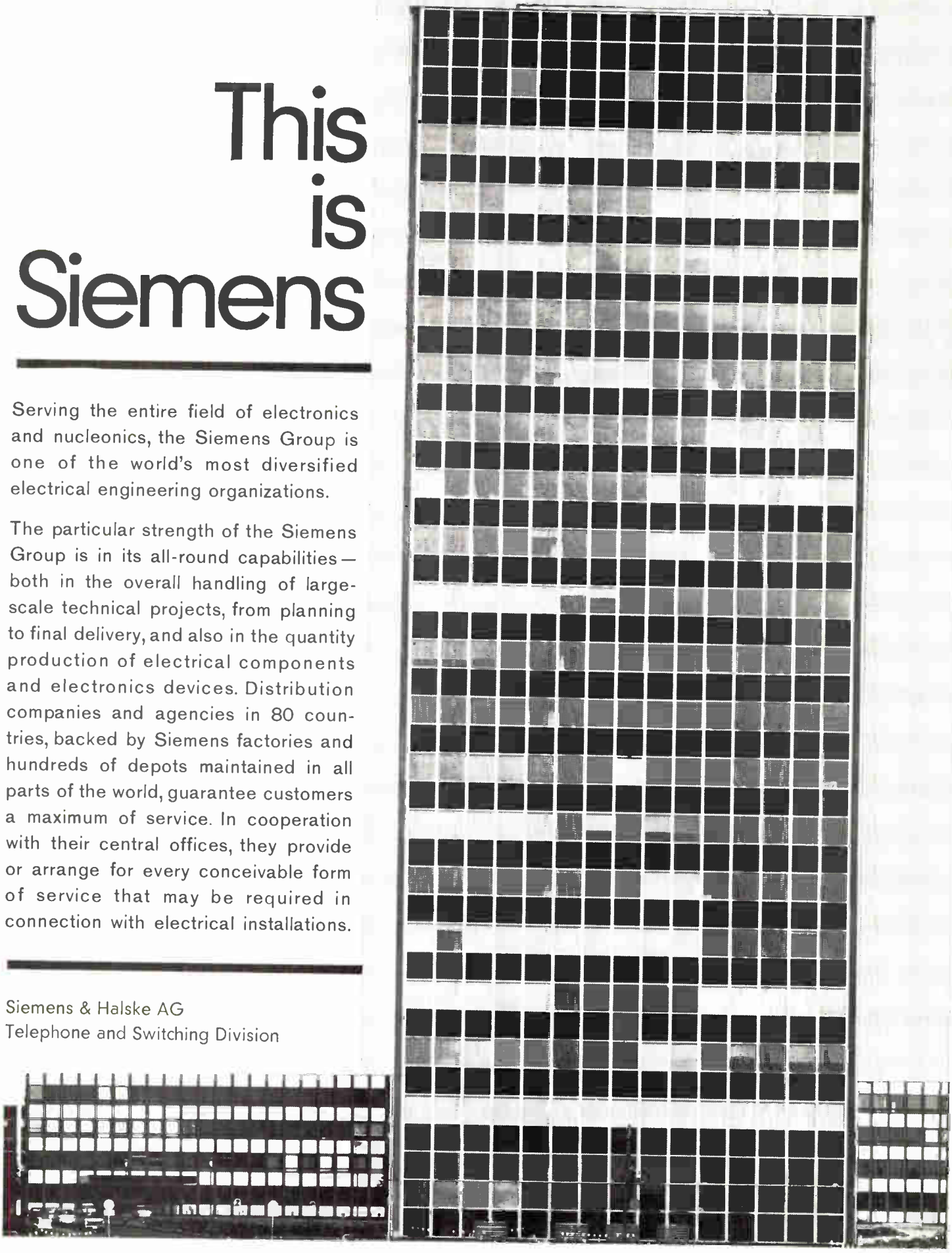
MANUFACTURER: TRIMPOT® & PRECISION POTENTIOMETERS, RELAYS; TRANSDUCERS FOR PRESSURE, POSITION, ACCELERATION. PLANTS: RIVERSIDE, CALIFORNIA; AMES, IOWA; TORONTO, CANADA

This is Siemens

Serving the entire field of electronics and nucleonics, the Siemens Group is one of the world's most diversified electrical engineering organizations.

The particular strength of the Siemens Group is in its all-round capabilities—both in the overall handling of large-scale technical projects, from planning to final delivery, and also in the quantity production of electrical components and electronics devices. Distribution companies and agencies in 80 countries, backed by Siemens factories and hundreds of depots maintained in all parts of the world, guarantee customers a maximum of service. In cooperation with their central offices, they provide or arrange for every conceivable form of service that may be required in connection with electrical installations.

Siemens & Halske AG
Telephone and Switching Division



SIEMENS

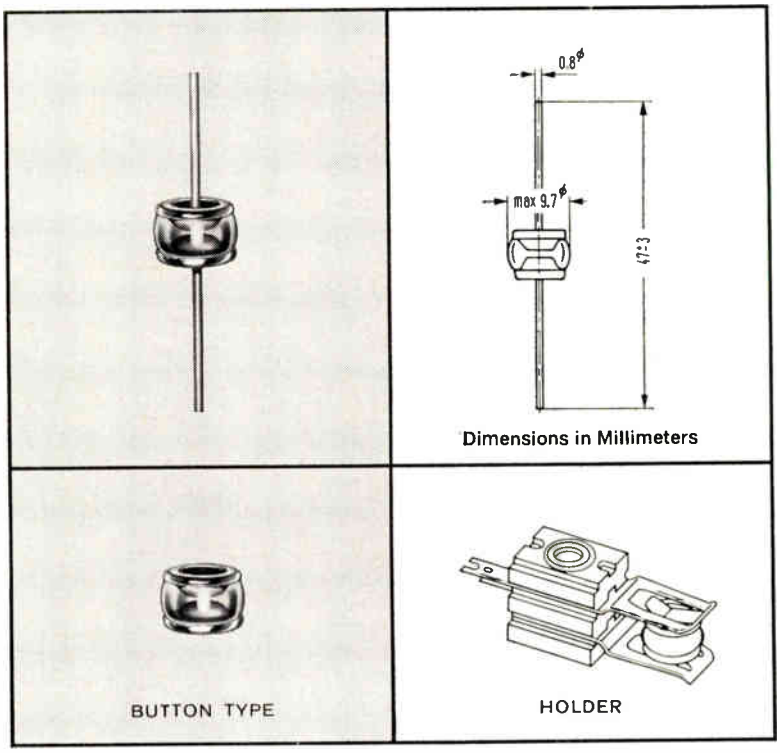
Siemens surge voltage protectors

The cost of surge voltage damage to delicate equipment runs high. Telecommunications and signaling apparatus, the entire range of solid state circuitry are completely vulnerable to uncontrolled surges, causing immediate damage. Due to short circuits, lightning flashes, electrical overloads or static charging, surge voltages may range from 200 to several thousand volts. In a community wide test, up to 600 surge voltages were recorded in a 10,000 hour period.

Low cost surge voltage protectors developed by Siemens give instant reaction—in .4 microseconds! Protectors shown here cost under one dollar in quantity. All fully protect valuable equipment and do a job that cannot be done by air gap or carbon block protectors.

These gas-filled glass protectors, installed between supply line and equipment, not only absorb the surge but reset automatically for continuous protection. In this price range the only proven arc-suppressors with a current carrying capacity up to 5,000A. Low capacitants (2 p F) for HF use. Standard models have a nominal DC striking voltage of 230V to 800V.

Immediate delivery from stock in White Plains, N.Y. 14 standard models available. Custom-designed also for particular applications.



Dimensions in Millimeters

WRITE NOW for full information on Surge Voltage Protectors

SIEMENS AMERICA INCORPORATED
Components Division
230 Ferris Avenue, White Plains, N. Y.

In Canada:
SIEMENS HALSKE SIEMENS SCHUCKERT (CANADA) LTD.
407 McGill Street, Montreal 1, P.Q.

COMING EVENTS

May

May 6-8: Nat'l Symp. on Human Factors in Electronics, IEEE; Sheraton Hotel, Boston, Mass.

May 9-13: Spring Mtg., Electrochemical Soc., ES; Sheraton-Palace Hotel, San Francisco, Calif.

May 10-12: Nat'l Aerospace Electronics Conf., AIAA, IEEE; Dayton, Ohio.

May 12-14: 8th Nat'l Power Instrumentation Symp., ISA; Commodore Hotel, New York, N. Y.

May 13-14: Symp. on Signal Transmission & Processing, IEEE; Columbia Univ., New York, N. Y.

May 17-20: Design Eng. Conf., ASME; Coliseum & Americana Hotel, New York, N. Y.

May 19-21: 4th Power Industry Computer Application Conf., IEEE; Jack Tar Harrison Hotel, Clearwater, Fla.

May 21: Conf. on Electronic Reliability, IEEE; Carnegie Foundation Bldg., New York, N. Y.

May 24-25: 9th Annual Rural Electrification Conf., IEEE; St. Francis Hotel, San Francisco, Calif.

May 24-26: 4th Annual Symp. on Microelectronics, IEEE; Chase Park Plaza Hotel, St. Louis, Mo.

May 24-29: 1965 IFIP Congress, IFIP; New York Hilton Hotel, New York, N. Y.

'65-'66 Highlights

WESCON, Western Electronic Show & Conv., Aug. 24-27, IEEE, WEMA; Cow Palace, San Francisco, Calif.

Nat'l Electronics Conf., Oct. 25-27; McCormick Place, Chicago, Ill.

NEREM, Northeast Research & Eng. Mtg., Nov. 3-5, IEEE; Boston, Mass.

IEEE Int'l Conv., Mar. 21-24, 1966; Coliseum, New York Hilton, New York, N. Y.

June

June 7-9: 1st Annual IEEE Communication Conv. (Globecom VII), IEEE; Univ. of Colo. & NBS Labs., Boulder, Colo.

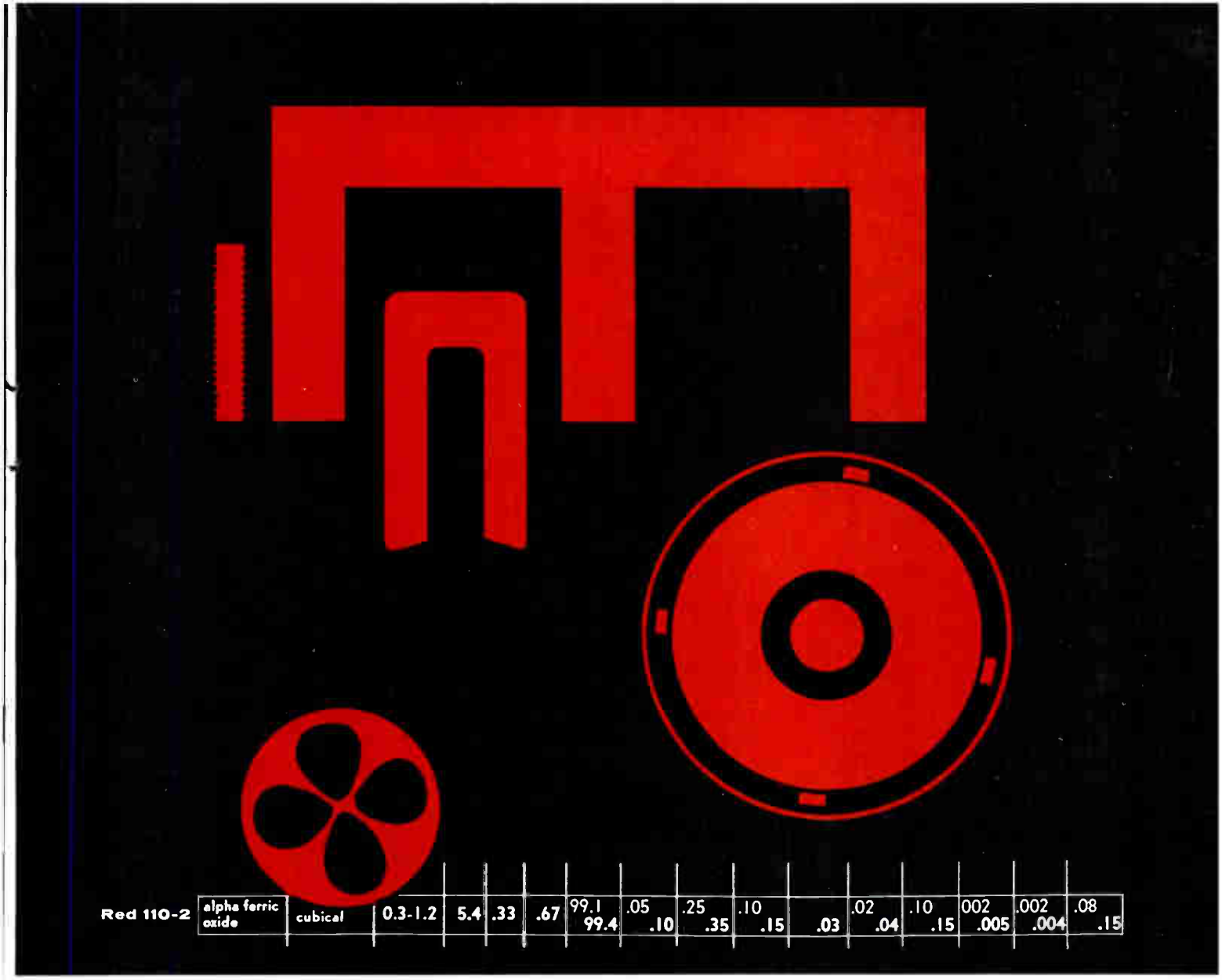
June 7-9: Symp. on Automatic Support Sys. for Adv. Maintainability, IEEE; Chase Park Plaza Hotel, St. Louis, Mo.

June 14-15: 1965 Midwest Symp. on Circuit Theory, IEEE & Colo. State Univ.; Colo. State Univ., Ft. Collins, Colo.

June 21-24: Aerospace Tech. Conf., IEEE; Shamrock-Hilton Hotel, Houston, Tex.

June 23-25: Joint Automatic Control Conf., IEEE, ASME, AIChE, ISA; Rensselaer Polytech Inst., Troy, N. Y.

June 27-July 2: Summer Power Mtg., IEEE; Detroit, Mich.



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

Columbian's Mapico focuses on the reduction of fluctuating characteristics in magnetic tape and ferrite components

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

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

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

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

COLUMBIAN CARBON COMPANY

Circle 10 on Inquiry Card

Report from

BELL LABORATORIES

SUPERCONDUCTING MAGNET FOR MASERS PROVIDES UNIFORM FIELD, ADJUSTABLE BANDWIDTH

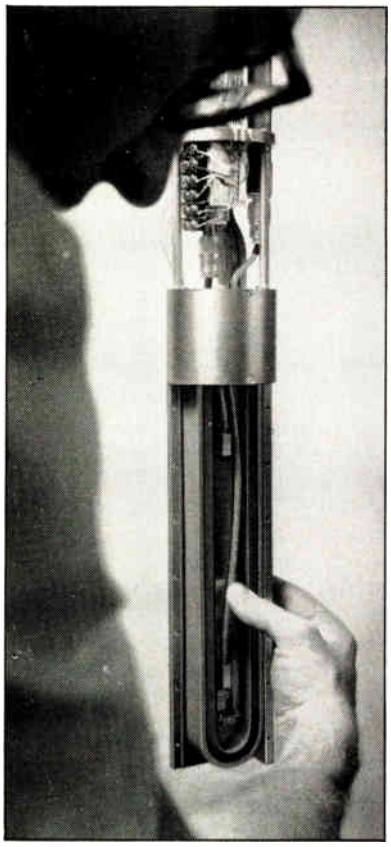
For efficient operation, a low-noise traveling-wave maser needs a very low-temperature environment such as that of liquid helium (4.2°K) and a uniform magnetic field which determines the maser's operating frequency. These requirements suggest using a superconducting magnet for providing the field.

A compact maser amplifier based on this concept has been developed at Bell Laboratories. It incorporates an 8-pound superconducting magnet immersed in liquid helium, replacing an earlier 500-pound Alnico magnet mounted outside the dewar. This maser also provides the desirable feature of an adjustable bandwidth of amplification.

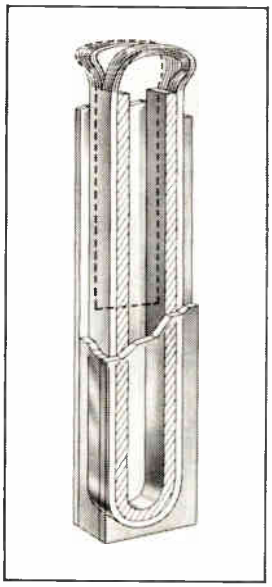
As shown in the illustrations, the uniform field is obtained with a superconducting solenoid enclosed in a close-fitting box of high-permeability iron. Adjustable bandwidth is obtained with an auxiliary superconducting trimmer coil which overlays one half the solenoid cross section. This coil modifies the main field, creating two discrete and individually uniform field regions. Changing the current in the coil adjusts the "step" between the two fields and thereby changes the bandwidth.

The two fields are each uniform to one part per thousand near 3300 gauss, and the maser bandwidth can be adjusted smoothly from 14 to 55mc centered at an operating frequency near 4170mc.

At the broadest band, its gain is 34db with an effective noise temperature of 5°K. The maser has demonstrated stable low-noise performance in a variety of satellite communications experiments.

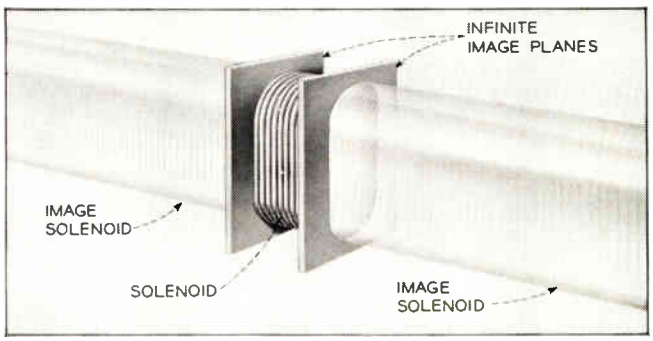


New maser magnet (left) has front and left side of enclosure removed to expose superconducting solenoid. Drawing (center) corresponds to photograph and shows solenoid inside box enclosure. Solenoid is wound on U-shaped nonmagnetic form and is spread apart at top to permit insertion of the maser. Dotted line indicates position of trimmer coil. Drawing at right indicates how front and rear plates of enclosure act as "image planes." These high-permeability plates are made to appear very large by the magnetic return paths provided by the sides of the box. The resulting magnetic field approximates the ideal uniform field of a solenoid of infinite length.

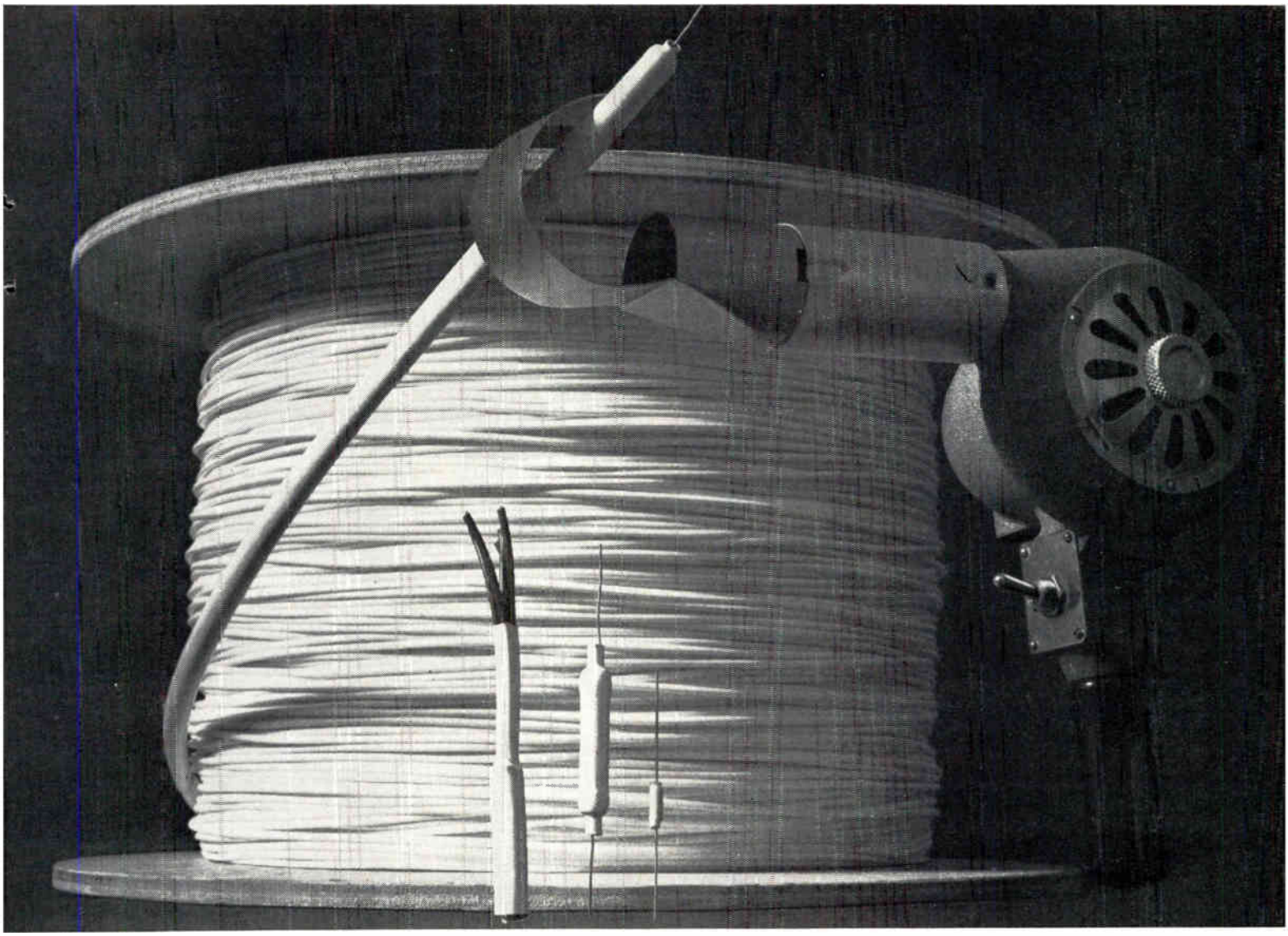


Bell Telephone Laboratories

Research and Development Unit of the Bell System



iNSULTITE
heat-shrinkable tubing



first of the iNSULRAD family of irradiated polyolefins from E.C.C.

Now there's an important new source of heat-shrinkable tubing—INSULTITE from Electronized Chemicals Corporation.

INSULTITE meets competitive heat-shrinkable tubing requirements spec for spec — *outperforms* other shrinkables in volume resistivity, longitudinal change, water absorption, and resistence to solvents.

INSULTITE is the answer wherever skin-tight packaging or encapsulating covers are needed. Apply heat: INSULTITE molds itself around smooth or irregular shapes to form a tight protective jacket.

INSULTITE is available in standard colors and sizes and is supplied in four-foot or specified lengths . . . . competitively priced, and available now. For more information on this new product fill out and return the coupon at right or call Electronized Chemicals Corporation, Burlington, Massachusetts — 617-272-2850.

ELECTRONIZED CHEMICALS CORPORATION

a subsidiary of **HIGH VOLTAGE ENGINEERING**

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Yes, I'd like to learn more about INSULTITE.

- ☐ Send literature
- ☐ Send samples
- ☐ Have a sales engineer call.

NAME .....

COMPANY .....

ADDRESS .....

CITY ..... STATE .....

WASHINGTON TRENDS

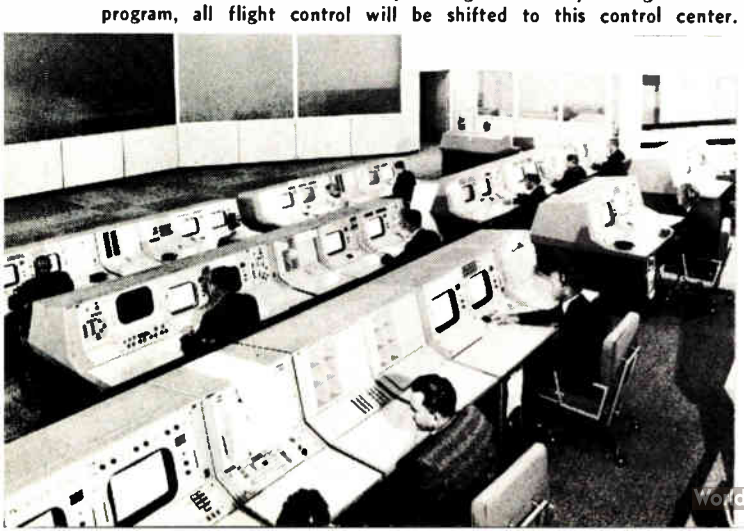
MORE POWER FOR FCC?—The Commission is urged to take legal control of the nation's 2,000 community antenna TV (CATV) systems. The TV Accessory Manufacturers Institute (TAME) petitioned the government to regulate CATV systems in much the same way as interstate phone systems. TAME asserts that continued lack of federal control over CATV will stifle construction of new stations on 70 UHF channels. Naturally, FCC is eager to extend its powers, but is somewhat reluctant to take the law into its own hands.

DISARMAMENT STUDY EXTENDED — We will continue research into arms control and disarmament devices and agreements by grace of Senate and House. They agree that the Arms Control and Disarmament Agency, born in 1961, should be extended. Neither, however, went along with President Johnson's request for a four-year, $55 million extension. Senate-House conferees are shaping up a compromise between the Senate's two-year and $20 million extention, and a three-year, $40 million plan by the House.

SMALL FIRMS CUT FEDERAL COSTS—Permitting small firms to bid on contracts—once placed only with large "sole source" suppliers—is saving U. S. money. Small Business Administration (SBA), bugging federal agencies to open more contracts to small firm bidding, says savings in eight months reached $6.5 million, savings came from lower unit costs by the small firms. SBA also has had the small business "set-aside program" expanded, under which more contracts are reserved strictly for small firm bidding. In January, such contracts iet reached $206 million, compared with $104 million a year earlier.

SPACECRAFT CONTROL CENTER

Interior of NASA Mission Control Center-Houston, hub of huge global network of tracking and communications stations with centralized control for all future manned space flights. Midway through Gemini program, all flight control will be shifted to this control center.



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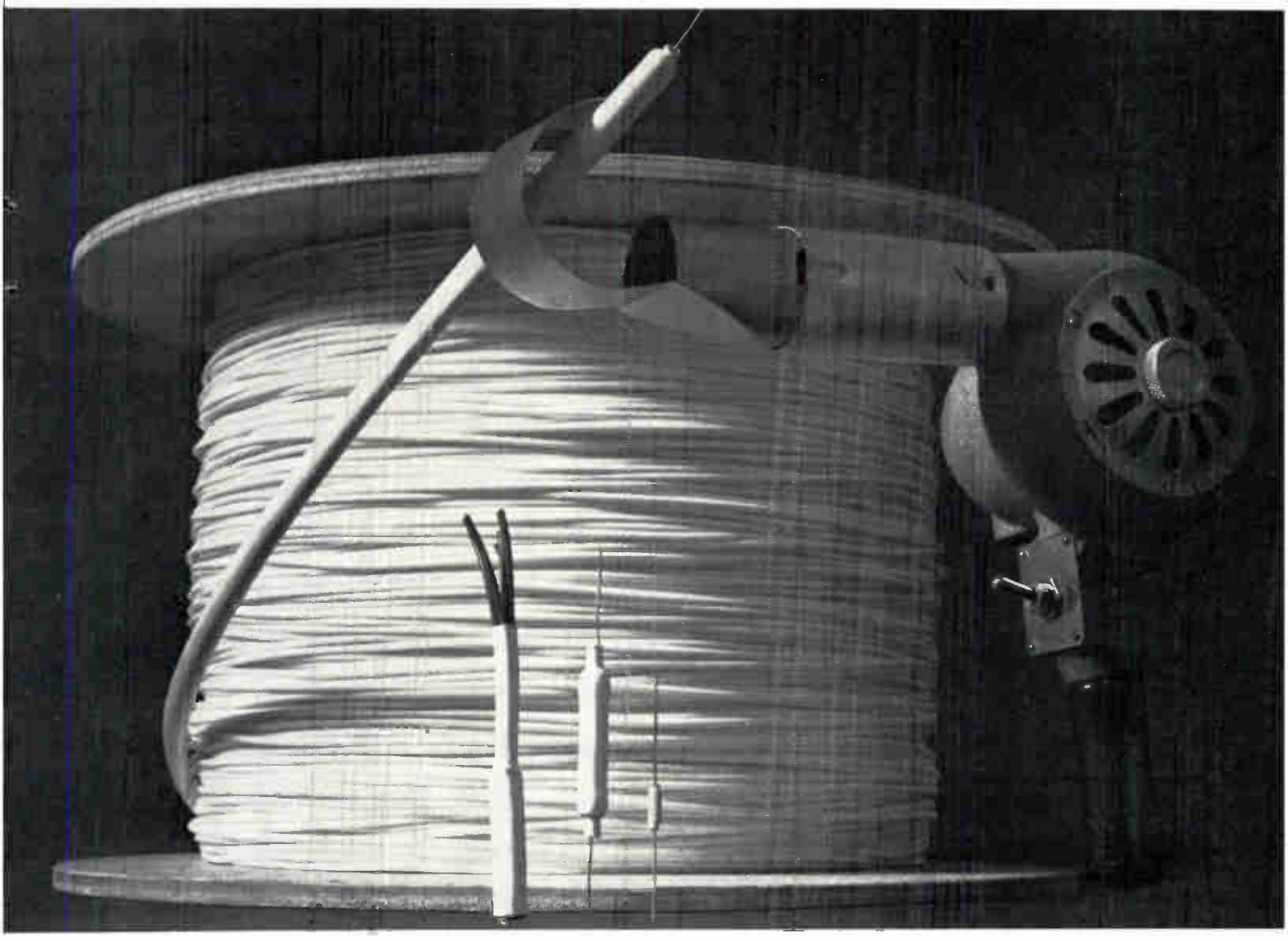
iNSULTITE
heat-shrinkable tubing



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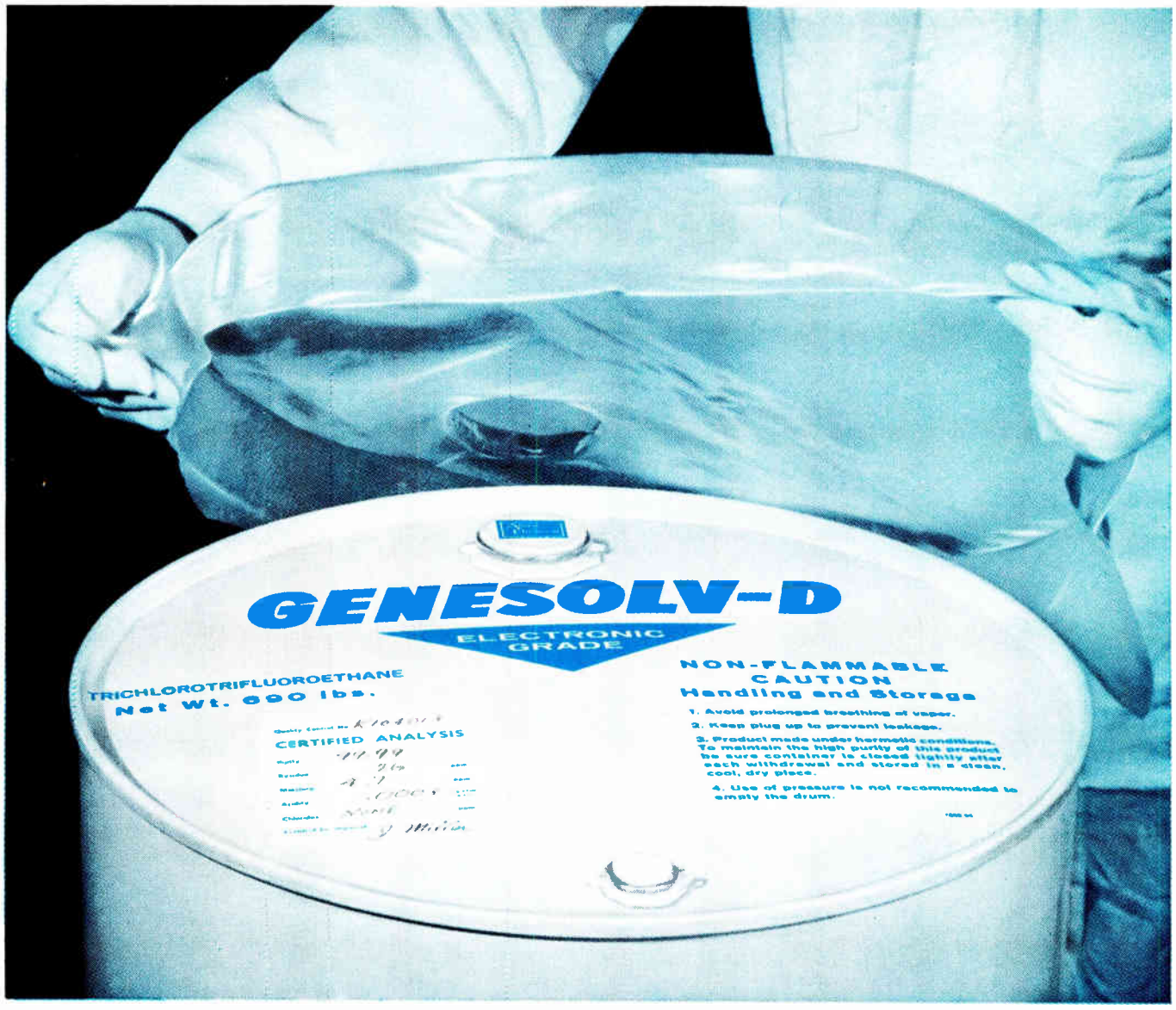


Purity plus protection . . .

certified ultra-clean

Genesolv® D Electronic Grade Solvent reaches the packaging stage 99.99% pure. Less than 1 ppm undissolved and dissolved residue. And it stays that pure all the way to your door.

We package it in plastic-lined steel drums under "class 100" clean room conditions. Our quality control inspectors analyze each drum's contents . . . mark the analysis on top . . . certify the contents ultra-clean. Finally, the drums are topped by snap-on plastic protectors that safeguard this purity.

Genesolv D Electronic Grade is signed, sealed and delivered ultra-clean. As a precision-cleaning agent, it offers you selectivity, low toxicity, nonflammability, low surface tension (increased wettability, with minimum dragout), quick drying . . . and certified purity.

Got a precision cleaning problem? Write or phone your nearest General Chemical office.

Allied Chemical

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

LOW NOISE, LOW DRIFT SOLID STATE AMPLIFIERS

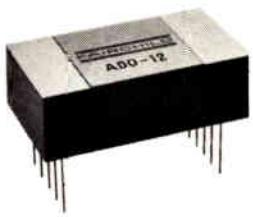
±100 Volt swing!

Operational Amplifier—AOO-7 Photo-resistor chopper stabilized operational amplifier. DC gain over 4 x 10⁷ (min). Gain bandwidth product = 1 mc (min). Output = ±100V. Drift < 1μV/°C. Maximum Load Current = 10mA to ground at ±100V. Short Circuit Proof. Slewing rate > 10V/μsec. No chopper drive required. Low noise. Dimensions: 4¾" x 1⅛" x 5". Prices: 1-4, $195; 5-9, $182; 10-24, $172; 25-99, $164.

Fast slewing rate: 12V/μsec

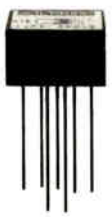
Differential Amplifier—ADO-11 Voltage Drift = 3μV/°C (max.). Gain Bandwidth Product = 1.6Mc (min.). Temperature range = −55°C to +125°C. Full compliance with MIL-D-16400 and MIL-E-5400. (Specify part number ADO-11M for 12V/μsec slewing rate.) Dimensions: 1" x 1⅛" x ½". Price: $150.

Low drift: 3μV/°C



Differential Amplifier—ADO-12 DC Voltage Gain = 30,000. Voltage Drift = 3μV/°C (max.). Differential Voltage = 6V (max.). Gain Bandwidth Product = 1.6Mc. (min.). Full compliance with MIL-D-16400 and MIL-E-5400. (Specify part number ADO-12M for 12V/μsec slewing rate.) Dimensions: 1" x 1¾" x 1½". Price: $450.

Low cost—high performance!



Differential Amplifier—ADO-3 Differential input single ended output. Gain = 20,000 or greater. Gain Bandwidth Product = 1.6 mc. Output = ±10V @ 1mA. Drift less than ±4mV from −25°C to +85°C. Size = 1⅛" x 1⅛" x ⅜". Lead spacing —0.1 inch grids. Prices: 1-4, $63; 5-9, $59; 10-24, $56; 25-99, $53.

FAIRCHILD SEMICONDUCTOR INSTRUMENTATION REPRESENTATIVES

ALABAMA *Huntsville: Gentry Associates, Inc., 534-9771.* **ARIZONA** *Scottsdale: G. S. Marshall, 946-4276.* **CALIFORNIA** *Los Angeles: Fairchild Semiconductor, 464-7464 / Palo Alto: Fairchild Sales Office and Factory, 962-2451 / San Diego: G. S. Marshall, 278-6350 / San Marino: G. S. Marshall, 681-3292* **COLORADO** *Denver: Hyer Electronics, 771-5285.* **CONNECTICUT** *Greenwich: Circuit Sales, 869-2244.* **FLORIDA** *Orlando: Gentry Associates, Inc., 424-0730 / St. Petersburg: Fairchild Semiconductor, 867-1824.* **GEORGIA** *Atlanta: Gentry Associates, Inc., 233-3816.* **ILLINOIS** *Oak Park: Fairchild Semiconductor, 848-5985.* **IOWA** *Cedar Rapids: Engineering Services Co., 366-7591.* **MARYLAND** *Bethesda: Bartlett Associates, Inc., 656-3061.* **MASSACHUSETTS** *Watertown: Circuit Sales, 926-1031.* **MICHIGAN** *Detroit: WKM Associates, Inc., 892-2500.* **MINNESOTA** *St. Paul: Northport Engineering, Inc., 698-3941.* **MISSOURI** *Kansas City: Engineering Services Co., 363-6000 / St. Louis: Engineering Services Co., 726-2233.* **NEW MEXICO** *Albuquerque: Hyer Electronics, 268-6744.* **NEW YORK** *Elmsford: SBM Associates, Inc., 592-8850 / Long Island: CDB Enterprises, 692-5200 / Massapequa, L.I.: Fairchild Semiconductor, 799-4590 / Rochester: SBM Associates, Inc., 271-7430 / Syracuse: SBM Associates, Inc., 454-9377.* **NORTH CAROLINA** *Burlington: Gentry Associates, Inc., 227-7916.* **OHIO** *Cleveland: WKM Associates, Inc., 885-5616 / Dayton: WKM Associates, Inc., 298-7203.* **PENNSYLVANIA** *Pittsburgh: WKM Associates, Inc., 892-2953 / Wayne: Bartlett Associates, Inc., 688-7325.* **TEXAS** *Dallas: Norvell Associates, Inc., FL 7-6451 / Houston: Norvell Associates, Inc., MO 5-0558.* **WASHINGTON** *Bellevue: Cane-Jessup Co. Inc., GL 4-0691.* **CANADA-ONTARIO** *Ottawa: Whittaker Electronics Ltd., 722-7558 / Weston: Whittaker Electronics Ltd., 247-7454.* **QUEBEC** *Roxboro: Whittaker Electronics Ltd., 648-3000.*

STOCKING DISTRIBUTORS

ARIZONA *Phoenix: Hamilton Electro of Arizona, 272-2601 / Scottsdale: G. S. Marshall, 946-4276.* **CALIFORNIA** *Los Angeles: Hamilton Electro Sales, 870-3300 / Palo Alto: Hamilton Electro Sales—North, 321-7541 / San Diego: Denny-Hamilton, 279-2412; G. S. Marshall, 278-6350 / San Marino: G. S. Marshall, 681-3292.* **CONNECTICUT** *Greenwich: L. L. Schley Co., 869-2244 / Hamden: Cramer Electronics, 288-7771.* **FLORIDA** *Orlando: Crescent Electronic Sales Co., 423-8586.* **ILLINOIS** *Chicago: Semiconductor Specialists, 622-8860.* **MASSACHUSETTS** *Newton: Cramer Electronics, 969-7700 / Watertown: L. L. Schley Co., 926-0235.* **MARYLAND** *Beltsville: Powell Electronics Washington, Inc., 474-1030.* **NEW YORK** *Westbury, Long Island: Schweber Electronics, 334-7474.* **PENNSYLVANIA** *Philadelphia: Powell Electronics, 724-1900.* **TEXAS** *Dallas: Norvell Associates, Inc., FL 7-6451 / Houston: Norvell Associates, Inc., MO 5-0558.*

F/1-12964-B(1)

And Accessories—All units featuring Silicon Planar reliability and 100 hour pre-aging.

1 μV/°C Thermal Drift!

Differential Amplifier—ADF-1 Drift=1μV/°C. from 0°C. to +60°C. Noise less than 5μV/p-p. Common mode rejection = 90 db @ 60 cps; 100 db @ DC. Fixed gain = 1000. Size = 1 11/32" x 1 11/32" x 1⅜". Output=20V/p-p @ 1mA. Pre-aged—100 hour operational test. Prices: 1-4, $190; 5-9, $177; 10-24, $167; 25-99, $160.

Fast slewing rate:>4.8V/μ Sec!

Operational Amplifier—AOD-4 Solid state, chopper stabilized. DC gain over 5 x 10⁶. Gain Bandwidth Product = 2 megacycles. Output = ±20V @ 2mA; ±10V @ 7mA. Drift less than 10μV/°C. from −20°C. to +85°C. Plug-in case 4" x 5" x 1". P.C. edge connector. No chopper drive required. Prices: 1-4, $92; 5-9, $86; 10-24, $81; 25-99, $77.

1 μV per week long term drift!

Operational Amplifier—AOD-6 Photo chopper stabilized. DC gain over 10⁷. Gain Bandwidth Product = 1 megacycle. Output = ±26V @ 5mA. Drift less than 0.5μV/°C. from 0°C. to +55°C. Long term drift 1μV per week. Plug-in case, precision connector; 1½" x 3" x 6". No chopper drive required. Prices: 1-4, $230; 5-9, $215; 10-24, $203, 25-99, $192.

Plus these Accessories

Power Supply—IPS-1 Powers up to five AOO-7's.

Rack Adapter—Type AA-1 Holds AOO-7's with IPS-1 in a standard 19" rack.

Voltage Reference Source—RVL-1 Stability better than ±0.01% per month.

Power Supply Regulator—PSR-1 Designed specifically for Fairchild Amplifiers.

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▼ **LEM IMPACT TEST**

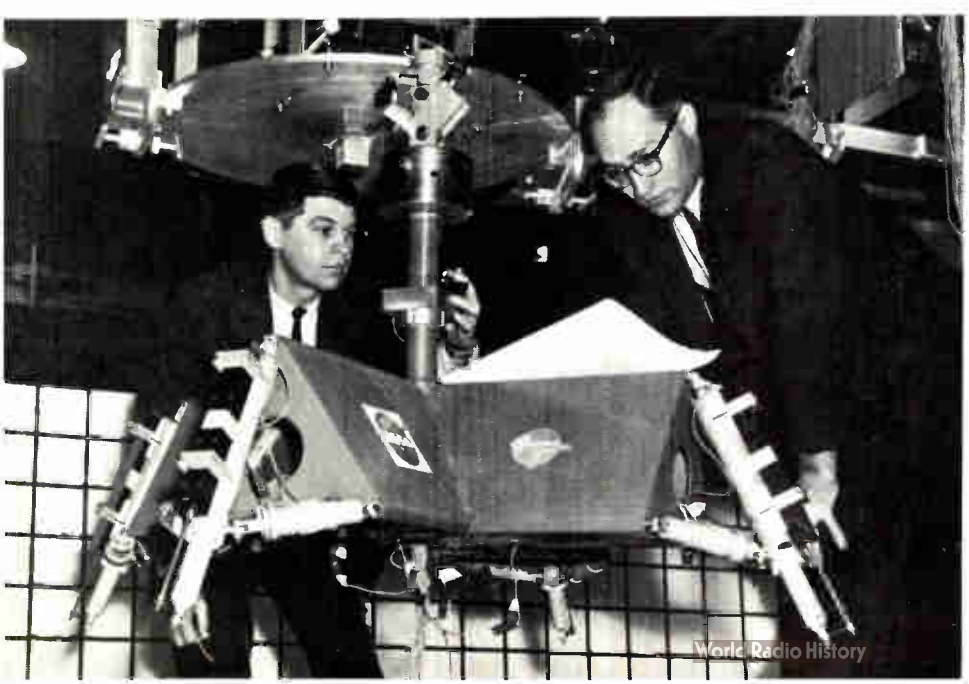
Landing technique engineers Frank Stafford (left) and David Brown prepare one-sixth scale model of Lunar Excursion Module landing gear for impact test and examine drop data at NASA MANNED SPACE CENTER.

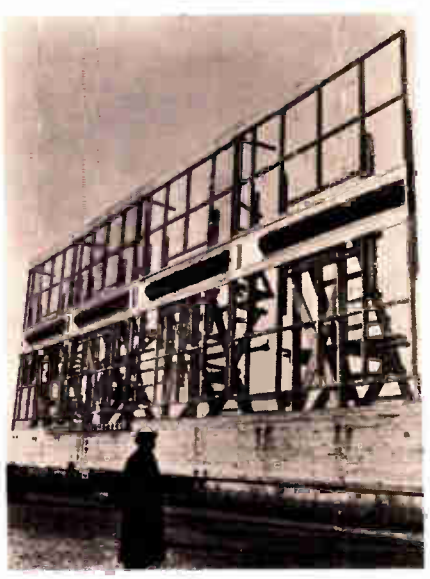
▲ **A "PERFECT" SIX**

3-D representation of structure of the word "Six." IBM engineer Robert Rew, and wife, Lois, phoneticist, teamed to give N. Y. Stock Exchange Data System a 126-word vocabulary to answer 400,000 telephone inquiries a day.

▼ **UHF TV ANTENNA**

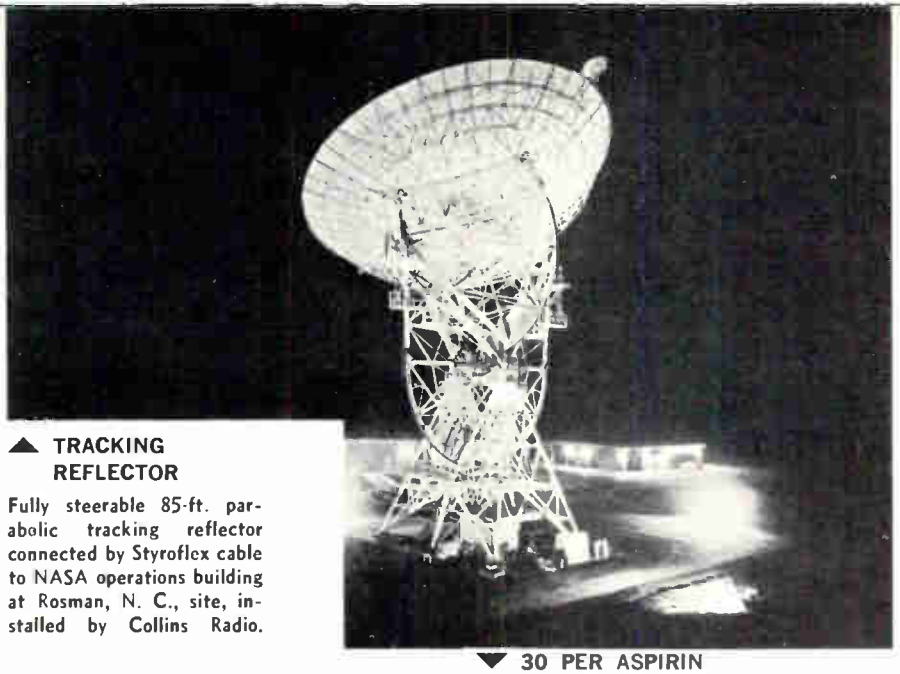
Massive turntable tests broadcast antenna at RCA proving site. View shows a 52-foot scheme of four tubular panels, one-half of antenna array to be mounted on Empire State Building and used by WNJU-TV, Newark.





ELECTRONIC SNAPSHOTS

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

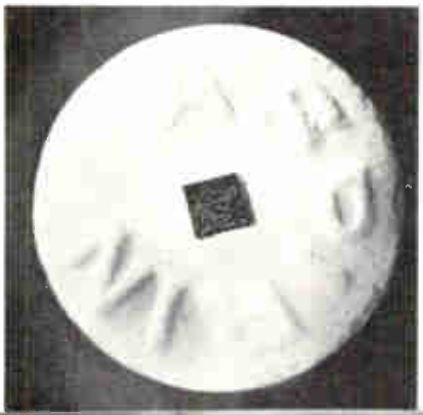


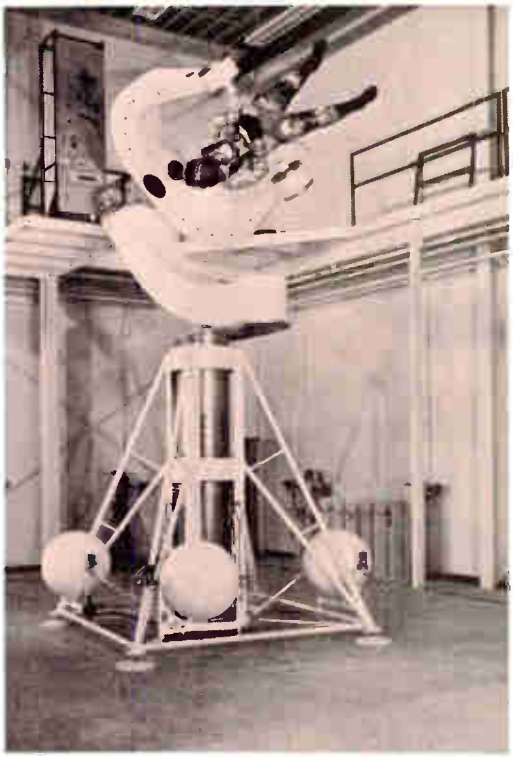
▲ **TRACKING REFLECTOR**

Fully steerable 85-ft. parabolic tracking reflector connected by Styroflex cable to NASA operations building at Rosman, N. C., site, installed by Collins Radio.

▼ **30 PER ASPIRIN**

Monolithic integrated circuits, devices so small that it takes 30 to cover an aspirin tablet, are the building blocks in Burroughs Corp. new D84 military computer. Tiny circuits help shrink unit to less than 1½ cu. ft.



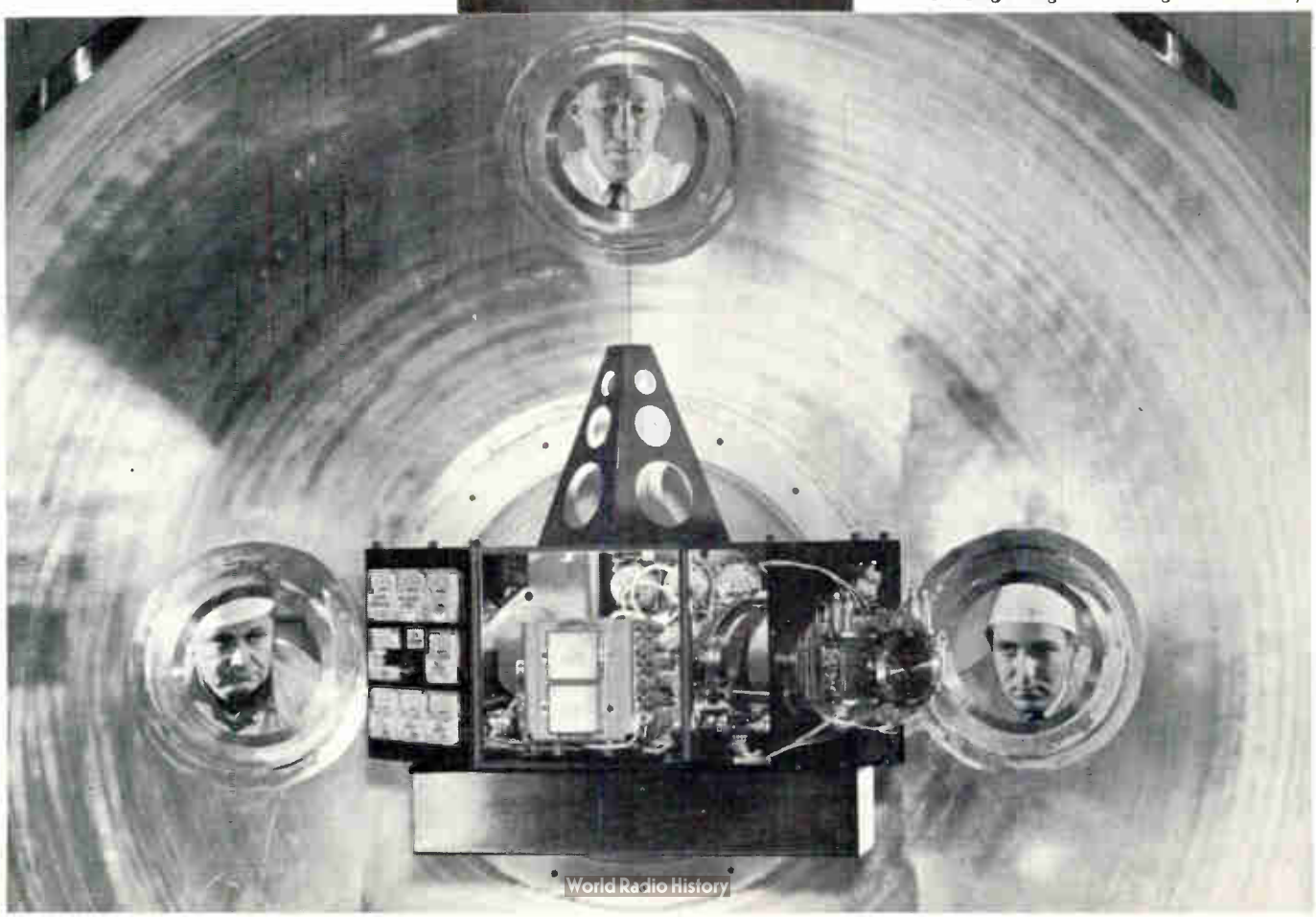


▲ **FIRST MANNED TEST**

Manned test of "first" weightlessness simulator designed by Convair, General Dynamics. Vehicle will be used to study design needs of astronauts, orbital labs and spacecraft.

▼ **STATION KEEPER**

Ion engines for station keeping and attitude control of large synchronous satellite are shown in vacuum chamber at Hughes Research Labs. Single engine is at right of assembly.



Microelectronics

The Cermet* Story

A Highly Sophisticated Versatile Material
with Unique Features and Varied Applications

Scientists and Engineers at CTS Corporation, Elkhart, Indiana, began over thirty years ago a continuing search for superior resistive materials. Hundreds of basic materials and thousands of resistive compositions have been analyzed, and the search will undoubtedly continue indefinitely. But several years ago a portion of this search was focused on ceramic-metallic compositions. The outcome of these investigations and the resulting applications are "The CERMET Story".

Most mixtures of ceramics and metals are either highly conductive or highly insulative depending upon their percentage composition, but several years ago mixtures of noble metals and glass frits were discovered which were semiconductive over narrow ranges. These early formulations were not commercially useful because of high current noise, high voltage and temperature co-efficients of resistance, and very poor reproducibility. These early formulations could be varied through a range of only a few hundred ohms per square. If formulations varied beyond a critical point, the resistivity of the film often decreased abruptly from a relatively high value to a very low one.

The Discovery

After several years of continuous study the CTS research staff learned to control the relationship between resistivity and the ingredient formulations. Improvements in noise, temperature and voltage stability, and reproducibility were also achieved. By 1958 CTS scientists and engineers had perfected a family of stable, reliable, economic, semiconducting films. This result led to the now famous CTS CERMET product line.

Production Methods

CERMET films are produced by screening formulations of conductive and insulating materials onto ceramic substrates. After firing at temperatures in excess of 600°C, a semiconducting alloy is formed which is permanently bonded onto the insulating substrate. A circuit or component produced in this manner is remarkably rugged and able to resist abrasion, heat-shock, humidity, oxidizing atmospheres, overload, and other environmental stresses.

Applications

CERMET films can also meet the demands of severe economic environments. Screening is a relatively simple process well adapted to automation. Resistors, capacitors and conductive networks can all be applied to a substrate by the same techniques and fired to fuse the components into an integrated circuit. External lead connections can be made by solder dipping the entire unit. (CERMET components are not damaged by the temperature of molten solder.) No costly high vacuum methods or elaborate mask making is required. Thus, many CERMET products are directly competitive with conventional items.

Fig. 1

CTS Corporation initially used CERMET films as resistive elements in potentiometers and trimmers. The dual tandem CERMET potentiometer (Fig. 1) is being used to replace wirewound units in commercial communications equipment for greater reliability and improved resolution.

Fig. 2

The reliability and the stability of CERMET films has been confirmed by the use of CTS CERMET trimmers, (Fig. 2) in electronic pacemakers inserted into the bodies of heart disease patients.

Fig. 3

CERMET films have also found ready acceptance as a material for manufacturing fixed resistors. The very high resistances available in short straight paths (for example, one megohm in .025″ x .075″ size) have made CTS CERMET films the logical choice for fixed resistors deposited on T05 headers (Fig. 3).

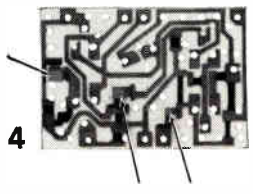


Fig. 4

In 1963 CTS developed a CERMET capacitor which is fully compatible with the CERMET resistance film. The CTS CERMET capacitor can be manufactured by the same inexpensive screening techniques and is fully operable over the same severe environmental conditions as are CERMET resistance films (Fig. 4).

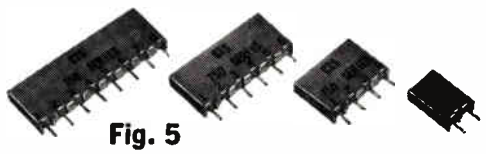


Fig. 5

CTS customers also asked for semiprecision resistor networks deposited onto ceramic blocks which can be automatically inserted into printed circuit boards. The resulting product (Fig. 5) has found extensive use in commercial data processing equipment.

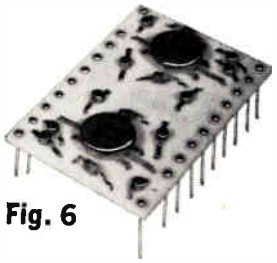


Fig. 6

The most recent chapter of the CERMET story has been written by a family of CTS CERMET hybrid integrated circuits which provide the basic building blocks for digital logic functions. The dual flip-flop (Fig. 6) has 14 diodes and 4 transistors on the upper side and 20 CERMET resistors, 4 CERMET capacitors, a CERMET lead crossover, and a CERMET conductive network on the under surface. A dual nand gate, a bistable flip-flop, a one shot multivibrator, an oscillator, a quad nand gate, and a quad analog gate (Fig. 7) are also being produced. These CERMET hybrid integrated circuits permit the circuit designer to combine the best available discrete active devices with rugged CTS CERMET passive components manufactured to extremely close tolerances. CTS hybrid integrated circuits provide excellent power handling capability, superior high frequency performance, and freedom from parasitics. CTS CERMET hybrid integrated circuits can also be made available in production quantities with relatively short lead times. The Re-entry Systems Department of General Electric Company was recently able to develop and deliver, in only sixteen weeks, a re-entry vehicle using CTS CERMET hybrid integrated circuits.

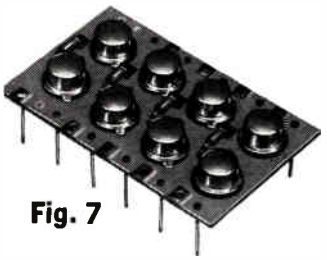


Fig. 7

What are your requirements for advanced microelectronic components or circuits? Your latest "design headache" may provide the plot for the next chapter in "The CERMET Story".

Write for a complete CERMET data kit.

*Trademark CTS Corporation

Founded 1896

CTS CORPORATION
Elkhart, Indiana

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Selector Switches
Loudspeakers
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Microminiature Components & Circuit Packages

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Chicago Telephone of California, Inc., South Pasadena, Calif.
CTS of Canada Ltd., Streetsville, Ontario
CTS Microelectronics, Inc., Ridgefield, Conn.
CTS Research, Inc., Lafayette, Ind.

Armco Thin Electrical Steels

Grade	Thickness mils	Core Loss Limit (400 cps) Induction kilogausses	Grain of Sample	Core Loss watts/lb	Description
ORIENTED T	1	10	Parallel	6.5	An oriented type with best permeability in the direction of rolling. Recommended for wound cores or stacked laminations with flux mostly in direction of strip length.
	2	15	Parallel	8.5	
	4	15	Parallel	6.5	
	5	15	Parallel	7.0	
	6	15	Parallel	7.5	
ORIENTED TS	4	—	Parallel	—	A super-oriented steel with very high permeability in rolling direction. (1800 min. at 10 oersteds) Designed for 400 cps service above 16 kilogausses.
TRAN-COR® T	5	10	50-50	6.5	Has good permeability in all directions. Designed for punched laminations in rotating equipment or sheared laminations with random flux.
	7	10	50-50	7.5	

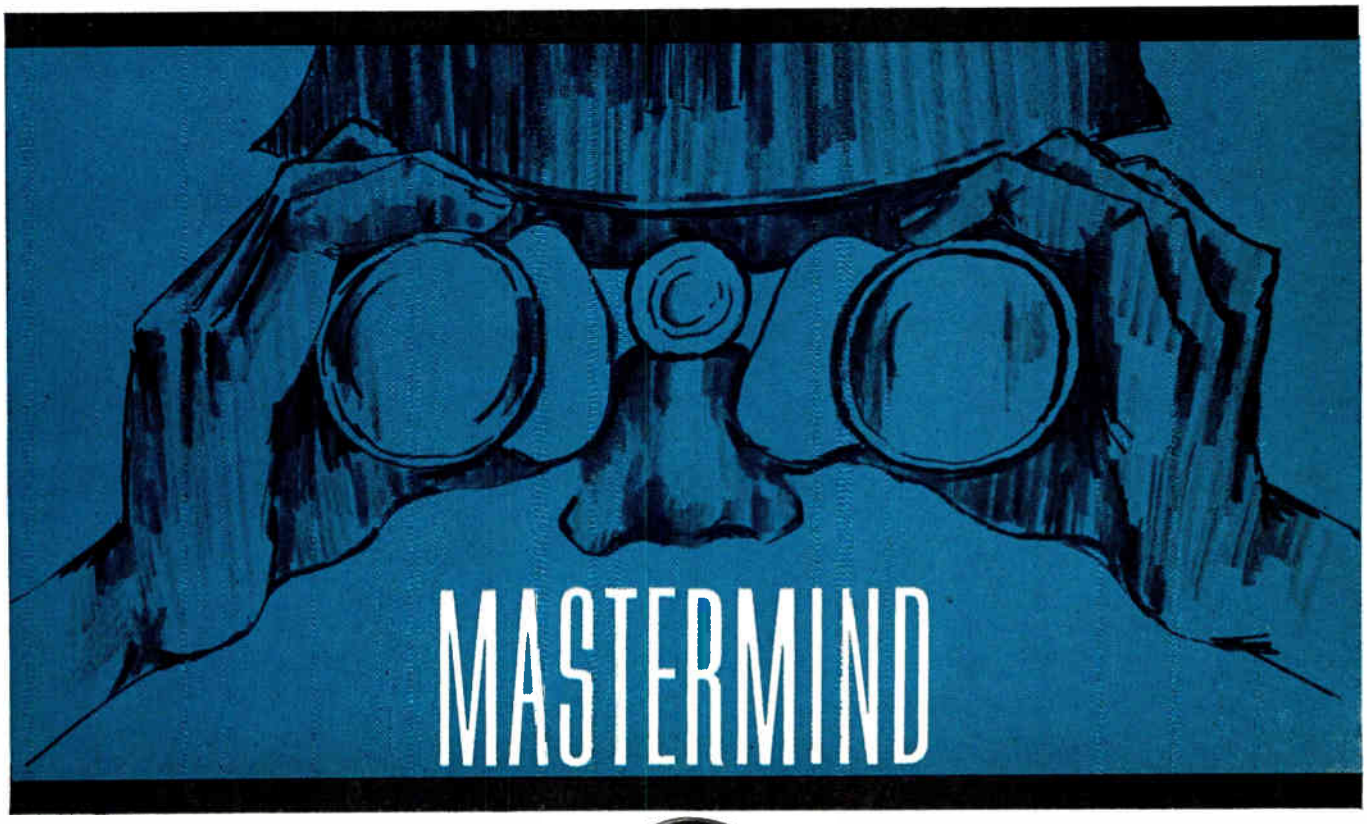
Use the selectivity offered by Armco Thin Electrical Steels for maximum efficiency, lowest costs

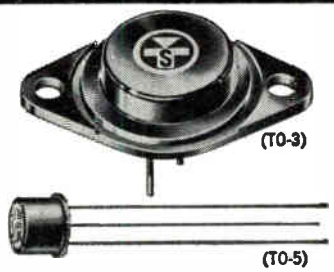
Armco Thin Electrical Steels provide materials that offer the selectivity necessary for the most effective design of high frequency devices in the fields of electronic communications and power generator and control. A wide range of properties, thicknesses, and grades enables you to select the material that most effectively and economically meets your needs. Special processing controls and production equipment, plus Armco's 60 years of experience in electrical steel production, assure you consistently uniform high quality.

Armco produces three different grades of Thin Electrical Steels—Armco TRAN-COR® T, Oriented T, and Oriented TS. All combine exceptionally high permeability, low hysteresis loss, a high lamination factor, and minimum interlaminar loss. Thickness tolerances are close, and magnetic properties are fully developed at the mill.

In addition, the extensive knowledge and experience of Armco engineers and metallurgists is available to assist you in both design and production. Why not make full use of the selectivity and consistently high quality of Armco Thin Electrical Steels? Write us for complete information. **Armco Steel Corporation, Steel Division, Dept. E-1925, P. O. Box 600, Middletown, Ohio 45042.**

ARMCO STEEL ARMCO





NPN SERIES 2N3232 THROUGH 2N3240 / PNP SERIES 2N3778 THROUGH 2N3782

These devilishly clever Industrial Silicon Power Transistors. Low cost, high quality, silicon power transistors specifically designed for industrial applications. The 2N3232-2N3240 series in the TO-3 header: maximum junction temperature of 200°C, D.C. power capabilities range from 117 to 200 watts, peak switched power ratings for approximately 20 times the D.C. ratings, maximum collector current capabilities range from 7.5 to 20 amps with BV_{CEO} ratings from 60 to 160 volts, saturation resistance values from 0.1 ohms @ I_C = 10A to 0.8 ohms @ I_C = 3A.

The PNP series 2N3778-2N3782 in the TO-5 package, are direct replacements for PNP germanium transistors. Use them as complementary drivers to the above NPN series. The PNP's are five basic types with D.C. power capability of 8.75 watts @ T_C = 25°C, BV_{CEO} ratings are from 40 to 100 volts, maximum collector current from 1.0 to 3 amps, maximum VCE(sat) from 1.0 to 0.75 ohms at I_C = 200 ma and 1.0 amps.

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DEFENSE DECLINE OVER, BUT MARKET CHARACTER CHANGING

The major part of the decline in defense business is now behind us, reports Harold Brown, Director of Defense Engineering and Research. Prime contracts in first half of Fiscal Year 1965 were down $900 million from first half of 1964. The decline occurred in the first four months of FY 1965.

For all of FY 1965, prime contract awards may fall about $500 million below FY 1964. Mr. Brown feels that during the second half of FY 1965 industry will, or should, make up part of the decline relative to FY 1964, which happened in the first half of the fiscal year.

Barring a major change in the international situation, he said, the overall level of the defense program should remain fairly stable for a few years. Changes in the composition of defense buying will go on. These changes will cause shifts between industries and sections of the country. Mr. Brown said the government would give as much advance warning as possible.

$1 BILLION MARKET POSSIBLE IN BIO-MEDICAL BY 1970

The current market of some $250 million in bio-medical electronics equipment may grow into a one-billion-dollar annual by 1970, largely owing to increasing application of space research findings to medical science. This is the opinion of Dr. Eugene B. Konecci, National Aeronautics and Space Council to members of the Space Medicine Section of the Medical Society of the State of New York.

Dr. Konecci cited aerospace bio-medical programs of NASA. These include bio-medical activities for projects Mercury, Gemini, and Appollo. He also mentioned advanced bio-medical instrumentation in the psychophysiological monitoring program, and the advanced life detection devices program.

SMALL BOAT PRODUCT SALE ESTIMATED AT $25 MILLION

Marine electronic products represent an annual market estimated at $25 million for recreational boats and small commercial fishing and transport craft. That market concensus is from specialists ranging from J. Leonard Lovett, general manager of Raytheon's Marine Products Operation, to Presley Taylor, manager of Kelvin & Hughes America Corp.

An $8 million market is seen in radio-telephones, determined by counting licenses assigned by the Federal Communications Commission. About $4 to $5 million worth of marine radar systems are sold annually.

DIGITAL COMPUTER CHECKS BANK TRANSACTIONS

Desk digital computer, developed by Digital Electronics, Inc., instantly checks authenticity of messages in inter-bank activity, now in use at Chase Manhattan Bank, New York. Each computer can index up to 999 identity numbers for member or corresponding banks.

LASER INDUSTRY SHAKING OUT, LOW DEMAND FOR PRODUCTS

The early glamour of the young laser "industry" is eroding under the harshness of economic reality. Technical Information Corp. (TIC), Glen Head, N. Y., reports that the industry is weeding out some firms that rushed into the field with the hope of getting in on the "ground floor."

The number of manufacturers has fallen, but total available pulsed laser products has increased from 55 to 70. Median prices showed a decrease from $10,375 to $9,950 in 1964. The costliest piece of equipment listed in 1964 was offered at $50,000, against a top figure of $43,000 so far this year.

According to Walter Venghaus, TIC president, the two main reasons for firms leaving the field are extremely high costs of R&D, and the relatively small demand for laser hardware. The U. S. Government is currently the major supporter of laser activity, spending about $30 million yearly; more than 75% of this is for basic research.

Emphasis on fundamental research and absence of a strong market for laser devices, reports Mr. Venghaus, is likely to result in another net decrease during the year in the number of companies producing commercial laser equipment.

The remaining companies may, however, expand their product lines in anticipation of a growing market which seems somewhat certain to emerge in the near future.

COLOR TV MAY BE READY FOR SALES BREAKTHROUGH

The year 1965 may see another breakthrough in color TV sales. A report issued by The Value Line Investment Survey suggests that the picture tube scarcity—a major sales deterrent until recently—seems to be over.

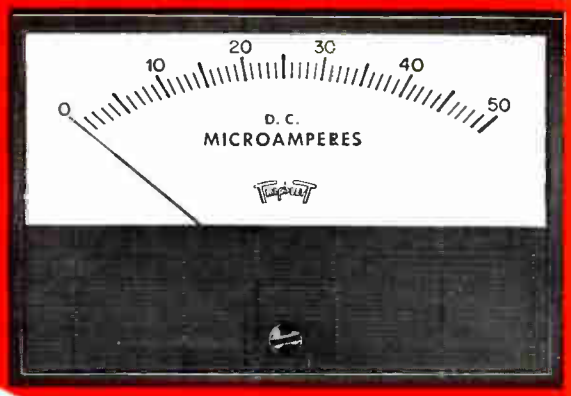
The report shows that color sales rose appreciably during the last quarter of 1964. The unit profit picture was helped by the lack of price cutting during the peak sales season.

According to the report, color set marketing could follow the black and white sales pattern; as the manufacturers begin to market a greater variety of color sets, competition may intensify, and price cutting will become inevitable. A downward pressure on profit margins will result.

PRIME CONTRACT AWARDS

Totals for contract awards of hard goods for Fiscal Years 1963 to 1966
(In billions of dollars)

Fiscal Year	1963	1964	1965	1966
Aircraft	$ 5.6	$ 6.2	$ 6.2	$ 5.8
Missiles	6.9	5.9	4.8	4.2
Ships	1.7	1.5	1.8	1.8
Ordnance, Vehicles, &c	2.2	1.7	1.9	2.0
Electronics & Communications	3.2	3.1	3.0	2.9
TOTAL HARD GOODS	$19.6	$18.4	$17.7	$16.7



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
5 sizes: 1-1/2", 2-1/2", 3-1/2", 4-1/2", 8"

MODEL 120 Edgewise Panel Meters

SHIELDED BAR-RING MOVEMENTS

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

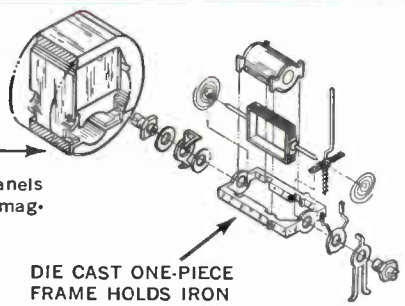
Not affected by magnetic panels or substantially by stray magnetic fields for D.C.

More Torque

Lower Terminal Resistance

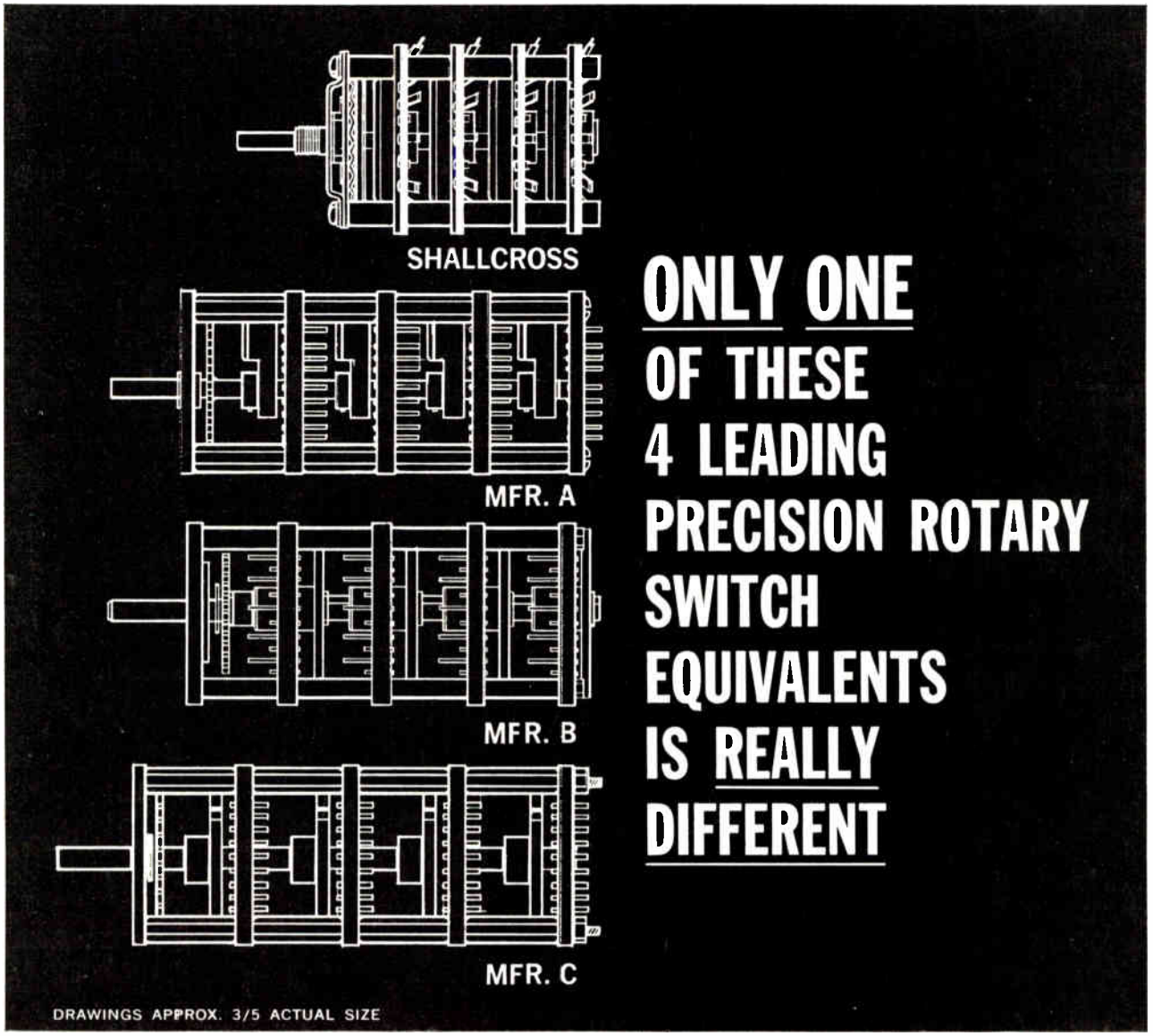
Faster Response

Exceedingly Rugged and Accurate



TRIPLETT ELECTRICAL INSTRUMENT COMPANY, BLUFFTON, OHIO

Circle 17 on Inquiry Card



ONLY ONE OF THESE 4 LEADING PRECISION ROTARY SWITCH EQUIVALENTS IS REALLY DIFFERENT

THE SHALLCROSS SWITCH ALONE PROVIDES THESE STANDARD FEATURES:
REDUCED BACK PANEL DEPTHS ■ FLARED, EASILY WIRED TERMINALS ■ DUST PROTECTED CONTACTS AND ARMS ■ LOWER WEIGHT ■ LOWER COST **PLUS** REPRODUCIBLE SPECIFICATION SHEETS TO PROMOTE ACCURATE AND PROMPT CONTROL DRAWINGS.

The SHALLCROSS departure from conventional precision switch design provides the important operational, installation, and value advantages listed above. In addition to the exclusive characteristics associated with our Series 2 switch line, there are other features which are shared only in part by competitive equivalents. They include: (a) Diallyl phthalate anti-backlash rotors; (b) stainless steel bushings and detent parts; (c) independently sprung dual-leaf wipers (silver); (d) epoxy fiber-glass stators; (e) integral contacts and terminals (silver).

The unique and near-unique combine in all SHALLCROSS switches to assure exceptional contact resistance vs load vs life characteristics; low thermal emf and switching noise; positive detenting; mechanical reliability, versatility and Mil-S-3786 performance. A comparison of Shallcross Rotary Switch Series 4 (2½") and Series 1 (one inch switch line coming soon) with competitive counterparts may also be made with profitable results — we suggest your own evaluation.

Shallcross
SELMA, N. C.

SHALLCROSS SELECTED SWITCH DISTRIBUTORS

ALLIED ELECTRONICS	TAYLOR ELECTRONICS	FORSBERG SALES	WESTEC ELECTRONICS	SAMCO ELECTRONIC SALES
Chicago, Illinois	Baldwin, New York	Brockton, Mass.	El Segundo, Cal.	Fairview Village, Pa.

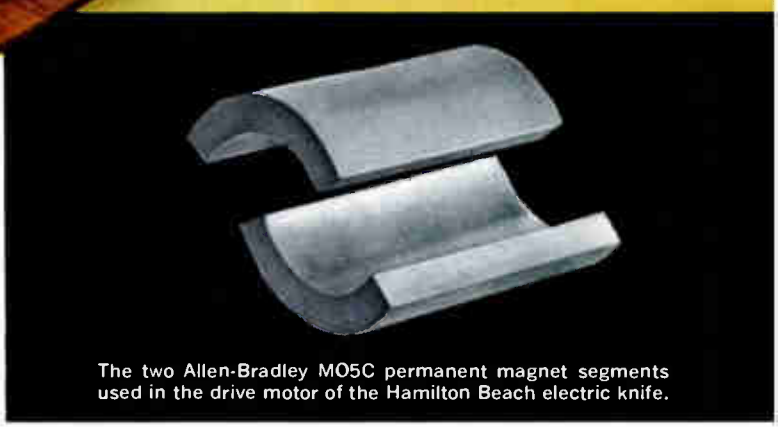
NEW CATALOG RS 100 DESCRIBES THE SHALLCROSS SWITCH LINE.

Circle 19 on Inquiry Card →

popular Hamilton Beach electric knife uses Allen-Bradley MO5C permanent magnets

PHOTOGRAPH COURTESY OF HAMILTON BEACH, A DIVISION OF SCOVILL MANUFACTURING COMPANY. "THE KNIFE WITH THE HOLE IN THE HANDLE" WAS WIDELY ADVERTISED ON TELEVISION AND IN LEADING CONSUMER MAGAZINES.

Hamilton Beach electric knife disassembled to show drive motor which uses Allen-Bradley MO5C permanent magnets. This smaller diameter permits the motor to be centrally located for improved balance and to provide more comfortable handling.



The two Allen-Bradley MO5C permanent magnet segments used in the drive motor of the Hamilton Beach electric knife.

■ The slim profile and ideal balance that characterize the Hamilton Beach knife is the achievement of outstanding design and Hamilton Beach engineering. The Allen-Bradley MO5C permanent magnets make it possible to develop a motor with the necessary smaller outside diameter while maintaining a uniform torque.

A-B Type MO5C is an oriented ceramic permanent magnet material which can be produced in shapes previously limited to unoriented materials. The peak energy is 2.6 times that of unoriented materials, and the high coercive force permits much shorter magnet lengths than with metallic magnets. Therefore, it is possible to reduce leakage flux and increase magnetic circuit efficiency.

The Type MO5C magnetic material is practical for motors from fractional to integral horsepower ratings, covering a wide range of speeds. And Allen-Bradley manufacturing capability can insure volume delivery while maintaining uniform quality. Technical Bulletin B5650A contains a story that should interest all manufacturers of small DC motors, as well as all manufacturers of small motor driven appliances and tools.

For your copy of Technical Bulletin B5650A, please write: Allen-Bradley Co., 222 West Greenfield Avenue, Milwaukee, Wisconsin 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ontario. Export Office: 630 Third Avenue, New York, New York, U.S.A. 10017.

A-B QUALITY

ALLEN-BRADLEY

QUALITY MOTOR CONTROL

QUALITY ELECTRONIC COMPONENTS

48-05-CE

Let's not be too quick with the answer!

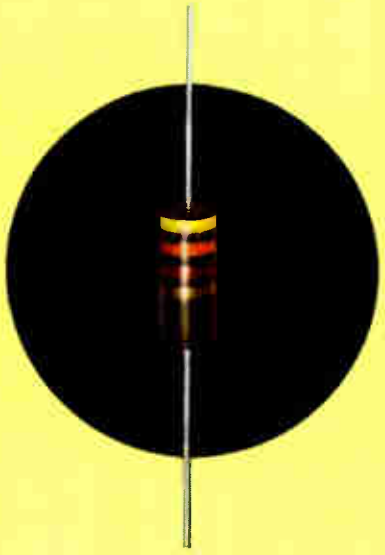
■ Here are some factors you should not overlook! When an assembly line test shows up a faulty cheap resistor, the correction costs you real money—more than you had hoped you would save by using resistors of marginal dependability. And, when you are mass producing in a highly competitive field, each reject can make the complete assembly a "no profit" item. Can you afford to mess around with such costly gambling?

Allen-Bradley does not believe so—and neither do the countless customers that have been using A-B quality resistors—by the billions—during the last several decades. Consequently, Allen-Bradley offers but *one* line of commercial resistors—whose "quality" has never been topped. When you specify Allen-Bradley resistors, there can be no doubt about the quality of the resistors going into your equipment.

All Allen-Bradley resistors are made by an exclusive hot molding process on special automatic machines designed and patented by Allen-Bradley. With the "human element" virtually eliminated, such uniform quality and consistent properties in production are so automatically assured that long term resistor performance can be accurately predicted.

What the Purchasing Department may consider too much of a "premium" to pay for the acknowledged superiority of Allen-Bradley hot molded fixed and variable resistors most likely would prove to be a "dividend" earned by your shop for its trouble free production and an improved quality of your equipment. After all, satisfied customers remain as advertisements for your product which money cannot buy.

So you see there are economic advantages in standardizing on Allen-Bradley hot molded resistors. Let's become better acquainted! Please write for Technical Bulletin 5050: Allen-Bradley Co., 222 W. Greenfield Avenue, Milwaukee, Wisconsin 53204. In Canada: Allen-Bradley Canada Ltd., Galt, Ontario.



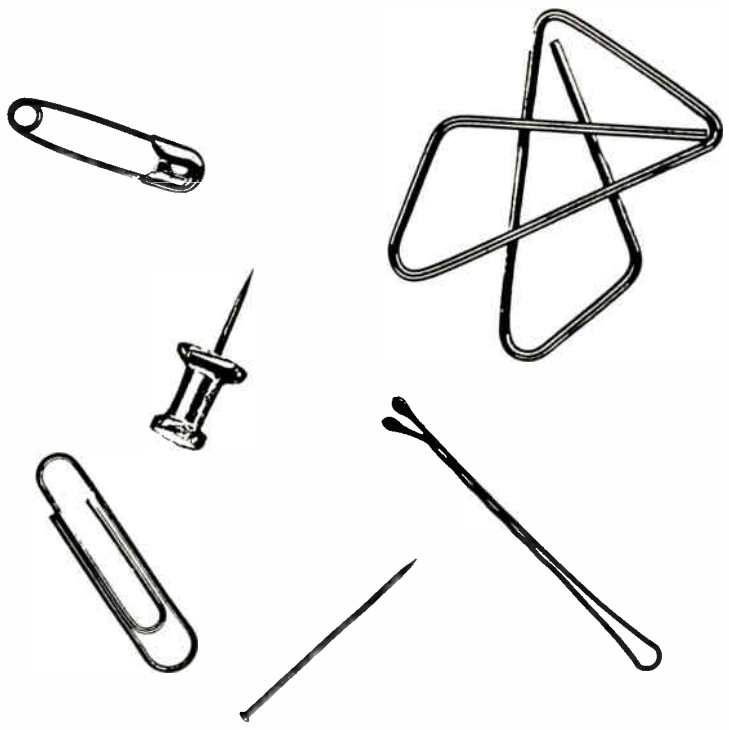
A-B HOT MOLDED RESISTORS are available in 1/8, 1/4, 1/2, 1, and 2-watt ratings, and in all standard EIA and MIL-R-11 resistance values and tolerances, plus values above and below standard limits.

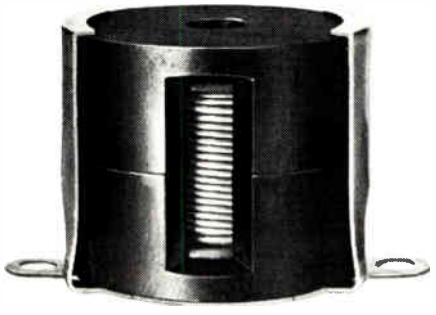
A-B

ALLEN-BRADLEY

QUALITY ELECTRONIC COMPONENTS

46-02-5E





TIMESAVERS, PURE AND SIMPLE

Ferrite Pot Core Hardware Cuts Assembly Time 50%

A one-piece spring steel housing snaps the core assembly into place, secures it to the chassis or printed circuit board, whittles minutes out of each production hour. In applications involving high quality inductors for filters, the trimming device has been simplified for hairline adjustment.

In addition to saving time, our ferrites give you extra design advantages with their high Q values and low disaccommodation factors. We guarantee permeability over a wide temperature range (−55°C to +70°C), and precision-ground air gaps assure uniformity of inductance throughout each production lot.

Manganese zinc ferrite cores are furnished in permeabilities of 650, 900, 1300 and 2000 for frequencies up to 2 MC. A 100 perm nickel zinc core covers frequencies up to 10 MC. There are 13 different sizes, including the International Electrotechnical Commission sizes—over 200 cores in all! For more information, write *Magnetics, Inc.* Dept. 31, Butler, Pa.

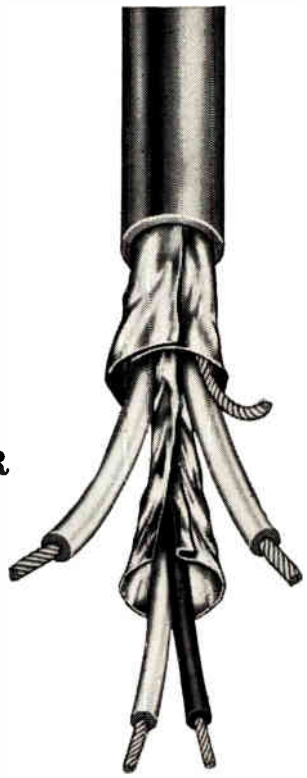
MAGNETICS inc.
®

Circle 21 on Inquiry Card

← Circle 20 on Inquiry Card

BELDEN INSTRUMENTATION CABLES KEEP YOUR SIGNALS CLEAN...

even in noisy environments



Belden electronic wire and cable provide a smooth, reliable path essential for your critical instrumentation signals. The complete Belden line includes cables designed to meet the various electrical, physical, and environmental requirements of your specific applications.

Many Belden cables feature Beldfoil† insulation with the exclusive Belden fold (U.S. Pat. 3,032,604). The benefits of this type of shield include:

1. **Increased electrical integrity**
2. **Reduction of crosstalk to unmeasurable levels**
3. **Reduced cable weight**
4. **Smaller cable diameters**
5. **Easier and faster shield terminations**
6. **Reduced costs**

The cables below are available from your Belden electronics distributor in convenient spool lengths. For other cable designs, request Catalog 865, or send us your specific problem for evaluation by a Belden specialist.

	Trade Number	Description	Nom. O.D. (Inch)	Nom. *Cap. (mmf/ft)	Nom. **Cap. (mmf/ft)	DC Resistance OHMS Per 1000' Per Conductor	Features
BELDFOIL Θ	8434	Tinned copper conductors, polyethylene insulated, black and red conductors under a Beldfoil aluminum-Mylar†† shield, stranded ground wire. Green and white conductors under overall Beldfoil shield, chrome vinyl jacket. AWG & Stranding—25 (7x33) —3 copper, 4 copperweld.	.179	25	40	45	High strength copperweld reinforced conductors 100% coverage Beldfoil shields.
BELDFOIL Θ	8723	Tinned copper, polypropylene insulated, black and red conductors, under Beldfoil aluminum-Mylar shield. Green and white conductors under a Beldfoil shield, each pair separate, stranded tinned copper drain wire, chrome vinyl jacket. AWG & Stranding—22 (7x30)—copper.	.165	35	62	16	100% Coverage Beldfoil shields 105°C operating temperature.
	8404	Tinned copper, polyethylene insulated, cabled, rayon braid, tinned copper braid shield, chrome vinyl jacket. AWG & Stranding—20 (26x34).	.255	25	45	11	Low DC resistance. Low capacitance.
	8424	Tinned copper, cotton wrap, rubber insulated, rayon braid, tinned copper braid shield, cotton wrap, black rubber jacket. AWG & Stranding—20 (26x34).	.295	55	95	11	Flexible at —40°C. Special high insulation resistance rubber.
	8700	Solid tinned copper, polypropylene insulation, copper braid, black vinyl jacket. AWG & Stranding—28 (solid)—coaxial.	.054	48	—	66	Extremely small coaxial cable 105°C operating temperature. May be steam autoclaved for medical research.
BELDFOIL	8640 8642	Solid copper, Beldsolt (solderable, no stripping required), Beldfoil aluminum-Mylar shield on each pair, copperweld ground drain wire, white vinyl jacket. AWG & Stranding—26 (solid)—1 pair.	.089 .140	80 80	140 140	41 41	Extremely small. Solderable without stripping, 100% coverage Beldfoil shield. 105°C operating temperature.
BELDFOIL Θ	8767 8768 8764 8765 8766	#22 Tinned copper, vinyl insulated, cabled in pairs, each pair and its ground wire under Beldfoil aluminum-Mylar shield, overall chrome vinyl jacket. 300 Volts suggested working voltage. Stranding—solid.	.270 .394 .425 .485 .510	40 40 40 40 40	77 77 77 77 77	16 16 16 16 16	100% Coverage Beldfoil shield. Maximum operating temperature 80°C. 3 Pairs to 15 pairs.
BELDFOIL Θ	8777 8778 8774 8775 8776 8769 8773	#22 Gauge tinned copper, polypropylene insulated, cabled in pairs, each pair and its ground wire under "Z" fold Beldfoil aluminum-Mylar shield, chrome vinyl jacket. Stranding—(7x30).	.270 .394 .425 .485 .510 .620 .760	30 30 30 30 30 30 30	55 55 55 55 55 55 55	16 16 16 16 16 16 16	Excellent high frequency characteristics and mechanical toughness. Maximum operating temperature 105°C. 3 Pairs to 27 pairs.

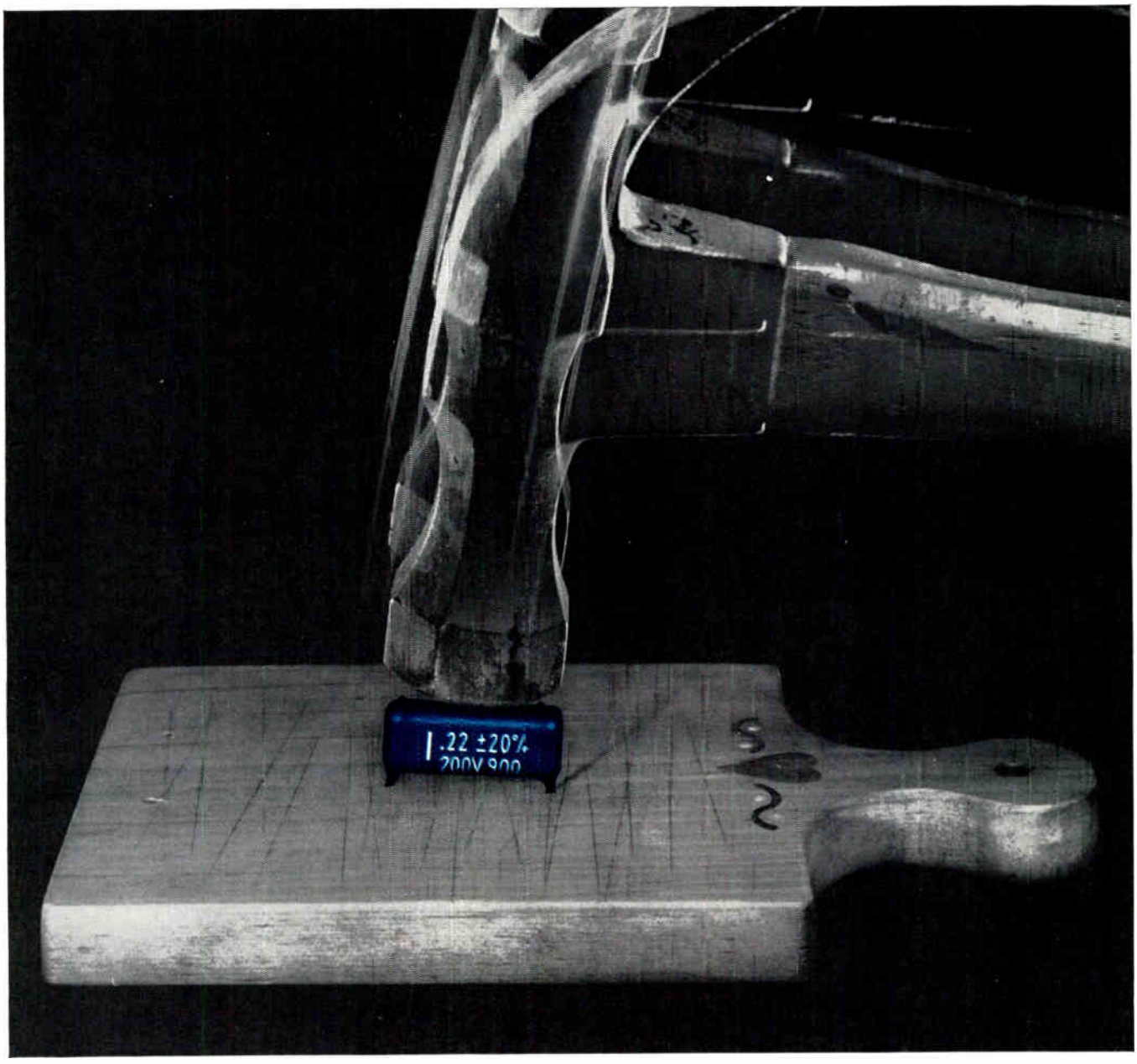
8-8-3

†Belden Trademark—Reg. U.S. Pat. Off.
Θ Has Belden Patented Fold—U.S. Pat. 3,032,604
††duPont Trademark

*Capacitance between conductors.
**Capacitance between 1 conductor and remaining conductors (if any) connected to shield.

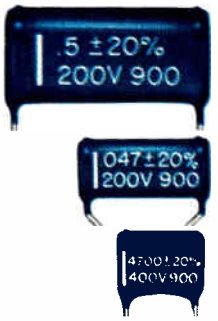
magnet wire • power supply cords • cord sets • portable cordage • control cables • electronic wire

BELDEN MANUFACTURING COMPANY • 415 South Kilpatrick Street • Chicago, Illinois 60644



GET PAKTRON® CAPACITORS ON THE BREADBOARD...

To keep the project reliable . . . get PAKTRON® hi-blu™ capacitors on the breadboard. These miniature high performance polyester film capacitors meet the exacting needs of a wide range of industrial, commercial and military applications. PAKTRON hi-blu capacitors deliver working voltages, capacitance values, tolerances, and an operating temperature range you'd expect to find in much larger (and much more expensive) capacitors. They also look good. We'll be glad to send samples.



Paktron® *hi-blu*™ epoxy coated polyester film capacitors

- Working Voltages: 100 to 600 WVDC
- Tolerances: ±5% to ±20%
- Operating Temperature Range: −55°C to +125°C

MB-1180 Series
1.180 inches long, maximum. Capacitance values 0.5 mfd.

MB-800 Series
.800 inches long, maximum. Capacitance values to 0.1 mfd.

MB-550 Series
.550 inches long, max. Capacitance values to 0.015 mfd.

"Remember, you're never more than a few feet away from a product of ITW"™

PAKTRON
DIVISION ILLINOIS TOOL WORKS INC.
1321 LESLIE AVENUE • ALEXANDRIA, VIRGINIA 22301

LETTERS

to the Editor

Editor, ELECTRONIC INDUSTRIES:

Your December 1964 editorial and the letter in the March 1965 issue from Prototype Electronic Engineering Company of California prompts me to point out that Canada has enjoyed such a service for the past 28 years. Canadian Research Institute was organized in 1938 as a commercial electronic research, and design organization, adding manufacturing facilities some seven years later.

While we do considerable work for companies which are not electronically oriented, contrary to the experience of our American counterpart, Canadian Research Institute's major business comes from government research organizations and the larger Canadian electronic companies. Perhaps the largest single reason for this is that, in this day of increasing specialization, we pride ourselves on being anti-specialists! Almost 50% of the electronic equipment and instrumentation developed by us utilizes, in addition to electronics, optics, medicine, acoustics, thermodynamics, hydraulics and mechanics.

R. Spencer Soanes,
Director
Canadian Research Institute
Don Mills, Ontario

Editor, ELECTRONIC INDUSTRIES:

With regard to both Engineer's Notebook No. 75, "Frequency Changes in Octaves" in Electronic Industries, dated December 1964, and the letter to the Editor on page 30 of Electronic Industries, dated February 1965 my recommendation for calculating octaves is:

$$\text{No. of octaves equals } 3.32 \log_{10}\frac{f_2}{f_1}$$

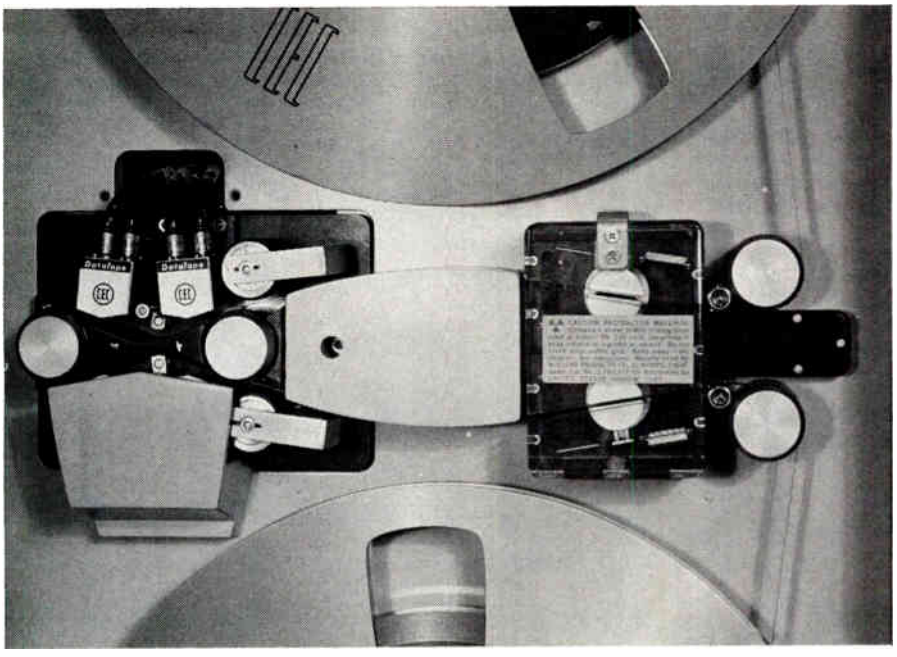
Regardless of its magnitude $\log_{10}(f_2/f_1)$ is readily obtained using a slide rule having an L scale.

The number of octaves is really $\log_2(f_2/f_1)$. The factor 3.32 is used in converting $\log_{10}$ quantities to $\log_2$ quantities and is equal to the reciprocal of $\log_{10}2$. An added bonus in remembering the factor 3.32 is:

No. of octaves equals
3.32 x No. of decades

Robert E. Margolies
Hughes Aircraft Co.
Culver City, Calif.

CEC's VR-3600 establishes new record for head life



It is not news that the VR-3600 is the most advanced of all magnetic tape recorder/reproducers. This has been proved in countless telemetry and laboratory applications. But what *is* news, is the remarkable durability of the instrument's recording heads.

All reports have shown that CEC's head life guarantee of 1000 hours is not only realistic but very conservative, since in virtually every case the new recording heads have surpassed this figure with little sign of wear. Compare the 1000 hour achievement with the performance of the VR-3600's closest competitor, and the savings to the user become significant indeed.

Reason behind the performance: these CEC recording heads are of a unique material and solid metal pole-tip design which completely eliminates the weaknesses of conventional head lamination or other solid-tip designs.

Result: a head that both provides superior performance at frequencies to 1.5 mc and reduces head wear and cleaning to a minimum.

Other advantages of the VR-3600 include...

1 **Bandwidth switchability.** With a mere flick of a switch, the operator may instantly change from wideband to narrow band, and back again—thus *doubling* the unit's capability with *no change* of components required. (On special order.)

2 **Constant flux recording** for assured machine-to-machine compatibility at all frequencies and tape speeds (with IRIG standards).

3 **Six speed switchable video FM**—d-c to 500 kc.

4 **Single source responsibility.** All components are designed and manufactured by CEC...including the video FM!

Important features:

◙ Pushbutton selection of *six* transport speeds along with associated electronics.

◙ Each of the VR-3600's 7 or 14 record/reproduce channels can be used for data storage in the 400 cps to 1.5 mc or d-c to 500 kc frequency range.

◙ Automatic end-of-reel sensing stops tape without leaders; transfer switch provides start command for nearby recorder and 30 second overlap of recorded data between machines—at no extra cost.

◙ IRIG or 18.24 kc AM servo system or time expansion/contraction servo system using common assemblies mean low cost for any version or combination of servo systems.

◙ Tape is constantly cleaned by optional vacuum/ionization; tension controlled, in all modes, by closed-loop servo control.

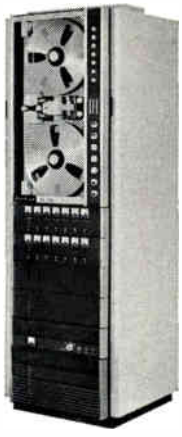
◙ Individual plug-in equalizers (6 per amplifier) meet all specifications simultaneously. Buy only those required, then set and forget.

◙ Record and reproduce amplifiers are solid state; the direct system fully amplitude- and phase-equalized.

◙ Tape transport skew is less than 0.5 μsec; complete cumulative flutter less than 0.30% p-p at 120 ips.

◙ The system may be supplied in single or dual rack configurations, with or without a dolly.

For *all* the facts about the VR-3600, call CEC or write for Bulletin 3600-X13.



CEC

Data Recorders Division

CONSOLIDATED ELECTRODYNAMICS

A SUBSIDIARY OF BELL & HOWELL/PASADENA, CALIF. 91109
INTERNATIONAL SUBSIDIARIES: WOKING, SURREY, ENGLAND AND FRIEDBERG (HESSEN), W. GERMANY

World's largest selection of adjustment potentiometers

BOURNS TRIMPOT® POTENTIOMETERS

More engineers specify Bourns TRIMPOT Potentiometers because:

TRIMPOT Potentiometer line is complete:
Bourns offers you the largest selection of adjustment potentiometers...33 standard models—4 terminal types—3 mounting styles.

TRIMPOT Potentiometers are small:
Space-saving size and choice of shapes permit the installation of up to 17 units (and sometimes even more) in one square inch of panel area.

TRIMPOT Potentiometers are accurate:
Screw-driver adjustment gives as much as 9000° of rotation ...you can make and repeat the finest adjustments.

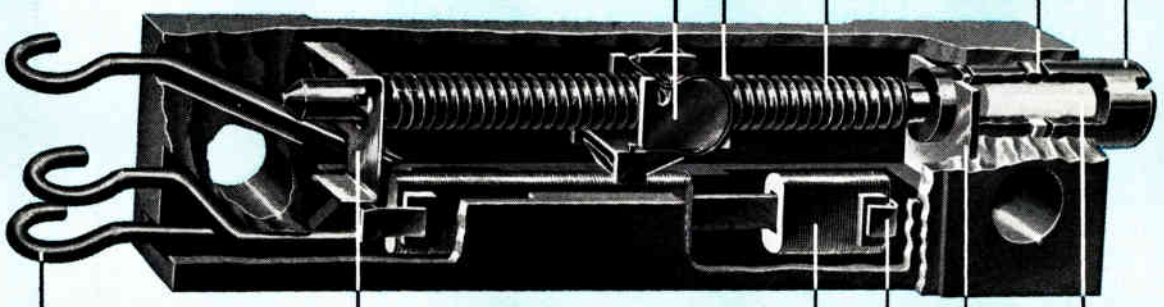
TRIMPOT Potentiometers are stable:
Adjustment shaft is self-locking...settings are virtually immune to acceleration, vibration and shock.

TRIMPOT Potentiometers are fully tested:
All units are 100% inspected before shipment and are checked by Bourns' exclusive Reliability Assurance Program to assure you of reliable performance.

TRIMPOT Potentiometers are proven:
They are backed by over 17 years of engineering know-how and have been specified and used in more military, industrial or commercial equipment than any other leadscrew potentiometer in the world!

REMEMBER—IF IT'S TRIMPOT, IT'S BOURNS

Only Bourns TRIMPOT Potentiometers Give You All Of These Outstanding Features



SPRING—Carriage spring provides positive no-slip performance during rotation plus a reliable idling feature at mechanical limits of travel.

LEADSCREW—Stainless steel leadscrew is corrosion-resistant.

O-RING—Silicone rubber O-ring seals potentiometer against humidity, withstands high temperature.

SHAFT HEAD—Stainless steel with machined slot for screwdriver adjustment. Meets military salt spray requirements.

WIPER—Gold-plated wiper carriage and precious-metal wiper for low noise. Carriage and wiper are welded together.

SOLDER TERMINALS—Tinned terminals are compact, yet large enough for easy soldering. Teflon-insulated leads and printed circuit pins are also available.

SILVERWELD® TERMINATION—This exclusive Bourns feature is unequalled in ruggedness. There is a metal-to-metal bond from the terminal to the resistance wire.

PICK-OFF—Precious-metal, positive-contact pick-off assures wiper continuity.

ELEMENT—Special ceramic element card for maximum reliability is precision wound with low-temperature-coefficient resistance wire.

SHAFT RETAINER—Shaft is locked in place for top performance under extreme shock, vibration and acceleration.

SHAFT INSULATOR—High-dielectric-strength, ceramic insulator isolates shaft head from internal circuits.

This cutaway of Model 224 shows the typical high quality to be found in all Bourns TRIMPOT potentiometers, although some features may vary from model to model.

...longest record of reliability

TRIMPOT® POTENTIOMETERS—UNSEALED

General-Purpose Wirewound Model 200. Max. temp. 105° C / L, S, P terminals / 0.50 watt at 70°C / 10 ohms to 100K.

General-Purpose RESISTON® Carbon Element Model 215. Max. temp. 125°C / L, S, P terminals / 0.25 watt at 50°C / 20K to 1 Meg.

High-Temperature Wirewound Model 260. Max. temp. 175°C / L, S, P terminals / 1.0 watt at 70°C / 10 ohms to 100K.

TRIMPOT POTENTIOMETERS—HUMIDITY PROOF

General-Purpose RESISTON Carbon Element Model 235. Max. temp. 135°C / L, S, P terminals / 0.25 watt at 50°C / 20K to 1 Meg.

General-Purpose Wirewound Model 236. Max. temp. 135°C / L, S, P terminals / 0.8 watt at 70°C / 10 ohms to 100K.

Micro-Miniature High-Temperature Wirewound Model 3000. Max. temp. 175°C / P terminals / 0.5 watt at 70°C / 50 ohms to 20K.

Micro-Miniature High-Temperature RESISTON Carbon Element Model 3001. Max. temp. 150°C / P terminals / 0.20 watt at 70°C / 20K to 1 Meg.

Sub-Miniature High-Temperature Wirewound Model 220. Max. temp. 175°C / L, W terminals / 1.0 watt at 70°C / 10 ohms to 30K / Mil-Spec style RT10 and meets MIL-R-27208A.

High-Temperature Wirewound Model 224. Max. temp. 175°C / L, S, P terminals / 1.0 watt at 70°C / 10 ohms to 100K / Mil-Spec style RT12 and meets MIL-R-27208A.

Ultra-Reliable High-Temperature Wirewound Model 224-500. Max. temp. 150°C / L, P terminals / 0.5 watt at 70°C / 100 ohms to 20K. Performance and reliability statistically verified to customer.

High-Temperature, High-Resistance RESISTON Carbon Element Model 3051. Max. temp. 150°C / L, S, P terminals / 0.25 watt at 50°C / 20K to 1 Meg / Mil-Spec style RJ11 and meets MIL-22097B.

High-Temperature High-Resistance PALIRIUM® Film Element Model 3052. Max. temp. 175°C / L, P terminals / 1.0 watt at 70°C / 10K to 1 Meg.

High-Temperature, Low-Resistance PALIRIUM Element Model 3053. Max. temp. 175°C / L, P terminals / 0.5 watt at 70°C / 2 ohms to 100 ohms.

High-Temperature Wirewound Model 3010. Max. temp. 175°C / L, P terminals / 1.0 watt at 70°C / 10 ohms to 100K / Mil-Spec style RT11 and meets MIL-R-27208A.

High-Temperature RESISTON Carbon Element Model 3011. Max. temp. 150°C / L, P terminals / 0.25 watt at 50°C / 20K to 1 Meg / Mil-Spec style RJ11 and meets MIL-R-22097B.

High-Temperature High-Resistance PALIRIUM Element Model 3012. Max. temp. 175°C / L, P terminals / 1.0 watt at 70°C / 10K to 1 Meg.

¾"-Square Wirewound Model 3280. Max. temp. 175°C / L, P, W terminals / 1.0 watt at 70°C / 10 ohms to 50K.

¾"-Square RESISTON Carbon Element Model 3281. Max. temp. 150°C / L, P, W terminals / 0.5 watt at 50°C / 20K to 1 Meg.

½"-Square, High-Temperature Wirewound Model 3250. Max. temp. 175°C / L, P, W terminals / 1.0 watt at 70°C / 10 ohms to 50K / Mil-Spec style RT22 and meets MIL-27208A.

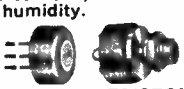
½"-Square High-Temperature RESISTON Carbon Element Model 3251. Max. temp. 150°C / L, P, W terminals / 0.50 watt at 50°C / 20K to 1 Meg / Mil-Spec style RJ22 and meets MIL-R-22097B.

BOURNS® SINGLE-TURN POTENTIOMETERS

⅜"-Diameter Micro-Miniature High-Temperature Humidity-Proof Wirewound Model 3300. Max. temp. 175°C / P, S terminals / 0.5 watt at 70°C / 50 ohms to 20K.

⅜"-Diameter Micro-Miniature High-Temperature Humidity-Proof RESISTON Carbon Element Model 3301. Max. temp. 150°C / P, S terminals / 0.25 watt at 70°C / 10K to 1 Meg.

Sub-Miniature Wirewound Model 3367. Max. temp. 105°C / P, S terminals / 0.5 watt at 70°C / 10 ohms to 20K / meets steady-state humidity.



Sub-Miniature RESISTON Carbon Element Model 3368. Max. temp. 105°C / P, S terminals / 0.25 watt at 50°C / 20K to 1 Meg / meets steady-state humidity.

LOW-COST COMMERCIAL POTENTIOMETERS

Wirewound TRIMIT® Potentiometers Models 271, 273, 275. Max. temp. 85°C / L, S, P terminals / 0.5 watt at 25°C / 50 ohms to 20K.

RESISTALOY® Carbon Element TRIMIT Models 272, 274, 276. Max. temp. 85°C / L, S, P terminals / 0.2 watt at 25°C / 20K to 1 Meg.

Wirewound E-Z-TRIM® Potentiometer Model 3067. Max. temp. 85°C / S, P terminals / 0.5 watt at 25°C / 100 ohms to 20K / Priced under $1 in production quantities.

Carbon Element E-Z-TRIM Potentiometer Model 3068. Max. temp. 85°C / S, P terminals / 0.2 watt at 25°C / 20K to 1 Meg.

SPECIAL-PURPOSE POTENTIOMETERS

High-Power (2 watts) High-Temperature Wirewound Model 207. Max. temp. 175°C / L terminals / 2 watts at 50°C / 100 ohms to 100K. As Rheostat Model 208, available 100K to 200K.

High-Power (5 watts) Humidity-Proof Wirewound Model 3020. Max. temp. 200°C / L terminals / 5.0 watts at 25°C / 100 ohms to 50K.

Dual-Element Wirewound TWIN-POT® Potentiometer Model 209. Max. temp. 135°C / L terminals / 0.50 watt (each element) at 70°C / 10 ohms to 50K.

15 watts, High-Temperature Wirewound Model 3030. Max. temp. 265°C / L terminals / 15 watts at 25°C / 10 ohms to 10K.

Radiation-Resistant, High-Temperature Wirewound Model 3040. Max. temp. 350°C / W terminals / 5.0 watts at 70°C / 500 ohms to 20K.

PANEL-MOUNTED POTENTIOMETERS

Most models are available with panel mounting. Unique design permits quick factory assembly to "on-the-shelf" units. In addition, mounting screws, brackets and clip brackets are available to meet almost any mounting requirement.

KEY TO TERMINAL TYPES

L=Insulated stranded leads
S=Solder lugs (includes panel-mounting bushing on Models 3367S, 3368S, 3300S and 3301S only)
P=Printed-circuit pins
W=Uninsulated wires (edge-mounting 3250, 3251, 3280 and 3281).

Write **TODAY** for detailed specifications on any model in the large BOURNS® Potentiometer and TRIMPOT® Potentiometer line **AND** a list of factory representatives.

Remember—
Don't MIL-SPECulate...
SPECify Bourns.

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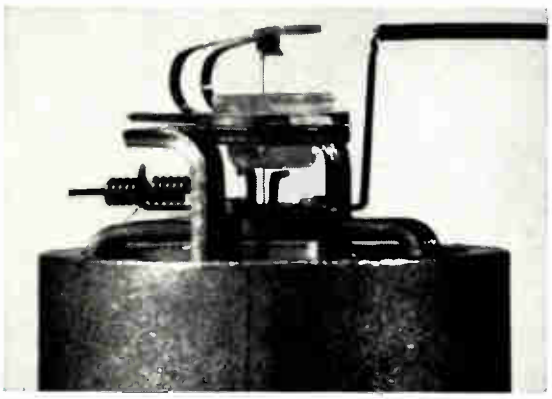
MANUFACTURER: TRIMPOT® & PRECISION POTENTIOMETERS, RELAYS; TRANSDUCERS FOR PRESSURE, POSITION, ACCELERATION. PLANTS: RIVERSIDE, CALIFORNIA; AMES, IOWA; TORONTO, CANADA

Better meter



Using advanced manufacturing techniques, Honeywell has perfected a meter mechanism which brings new reliability to low-priced panel meters.

It's the astonishing new AUTO-TORQUE mechanism.

As you can see from the photograph, AUTO-TORQUE's design is remarkably clean and uncluttered. Parts have been reduced 50%. There are no pivots and jewels. No hairsprings. No screws. No nuts. And the mechanism is self-shielded, too — a feature which makes special calibration unnecessary.

Honeywell's AUTO-TORQUE mechanism is almost completely machine-made. Parts are made to tighter tolerances to permit automated assembly. Any chance for slip-ups in manufacture is virtually nil.

FRICTION-FREE, PROTECTED FROM SHOCKS

In more conventional meters you get friction and wear. However, meters with Honeywell's new AUTO-TORQUE design operate completely friction-free. The moving system is suspended on metal bands under tension. Positive stops restrict travel of the moving system to prevent undue stress on the bands under extreme operating conditions. Result: repeatability and toughness never possible before with conventional meters.

Better buy

You might expect to pay considerably more for Honeywell meters with the AUTO-TORQUE mechanism. Actually you pay less in OEM quantities. For large-volume buyers, savings will be particularly impressive. And remember — meters with the new AUTO-TORQUE mechanism meet the highest standards — and are backed by Honeywell, a leader in quality meters of all types.

Honeywell's MM and MS meters are the first to feature the new mechanism. On the outside, crisp-looking case, easy-to-read face. On the inside, the more reliable, tougher yet less expensive AUTO-TORQUE mechanism.

Better check Honeywell

Honeywell, Precision Meter Division, Manchester, New Hampshire 03105.

Please send me more information on this important advance in meter design.

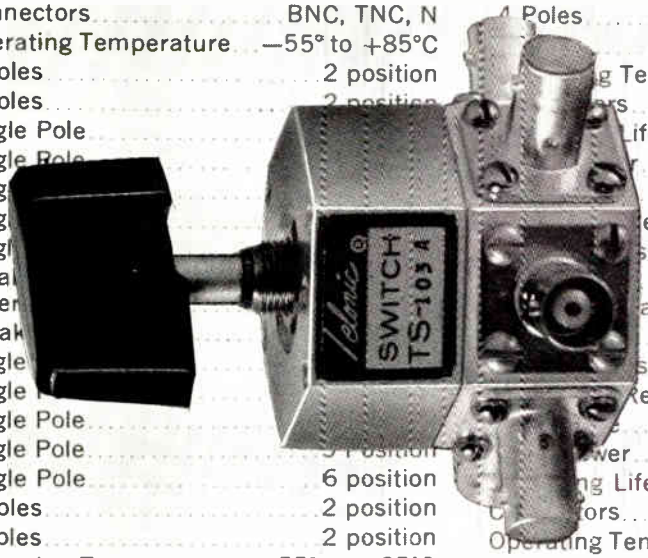
Name_____ Title_____

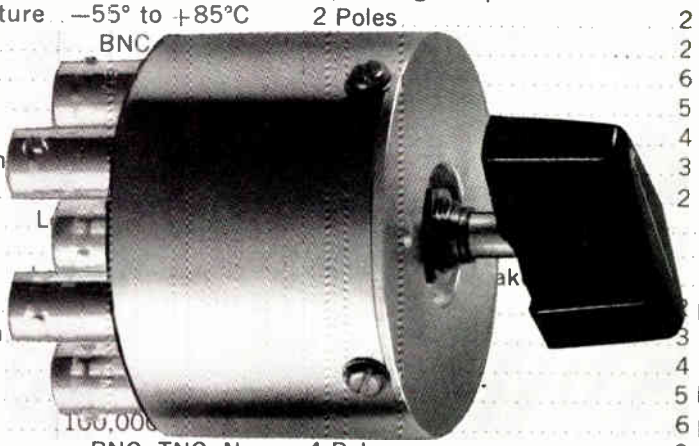
Company_____

Address_____

City_____ State_____ Zip_____

VSWR	Less than 1.1 to 1
Insertion Loss	Less than 0.1 db
Cross Talk Rejection	Over 70 db
Impedance	50 ohms
Input Power	100 watts
Operating Life	100,000 cycles
Connectors	BNC, TNC, N
Operating Temperature	—55° to +85°C
2 Poles	2 position
4 Poles	2 position
Single Pole	6 position
Single Pole	5 Position
Single Pole	4 position
Single Pole	3 position
Single Pole	2 position
Break before make	
Silver Plated	
Frequency Range	0-1500 mc





Telonic Coaxial Switches (0 to 1500 MC) with

SPECS TO SPARE

Telonic engineers have given you plenty of elbow room when they designed the manually operated coaxial switches shown above. Their specifications are well in excess of normal requirements. The frequency range, for example, covers microwave band, video, VHF and UHF signals. Other specs such as minimum insertion loss (less than 0.1 db at 1000 MC), low VSWR (less than 1.1 to 1 to 1,000 MC) and negligible cross talk rejection (over 70 db at 1000 MC) are meant to impress. The coaxial switch allows you to monitor, align, and adjust several RF and IF circuits without changing cable connections. Time generally allotted for quality control is dramatically reduced. Telonic coaxial switches are lightweight and low cost, yet have silver plated, self-cleaning switch contacts for positive action and long life. Off-the-shelf delivery of most models. Models available include: double pole, double throw; 4 pole, double throw; and single pole from two to six postions. All units are available with ganged wafer switch sections so that DC and low frequency circuits can be switched simultaneously with the coaxial RF Section. Write for data.

Telonic® INDUSTRIES, INC.

60 North First Avenue, BEECH GROVE, INDIANA

Representatives in: Baltimore, Boston, Chicago, Cleveland, Dallas, Dayton, Denver, Huntsville, Indianapolis, Los Angeles, New York City, Orlando, Philadelphia, San Francisco, Seattle, St. Louis, Syracuse and principal cities throughout the world.

• SWEEP GENERATORS • RF ATTENUATORS • CW OSCILLATORS • COAXIAL SWITCHES

Circle 28 on Inquiry Card

A COOL 400 V

Delco Radio's new DTS 413 and DTS 423 power transistors, are conservatively rated at 75 and 100 watts. Our standard TO-3 package assures low thermal resistance (junction to heat sink 1.0°C per watt) for cool power. The silicon element gives you high voltage protection, high frequency response and low saturation voltage.

The price is low (less than 3¢ a volt for sample quantities) for two reasons: special inter-digitated geometry of the devices and our unique 3D* process for high yields.

Now you can reduce current, the size of other components, and increase efficiency in high energy circuits. Vertical and horizontal TV outputs, for example.

Your Delco Radio Semiconductor distributor has these two new power transistors on his shelf. Call him today for data sheets, prices and delivery.

*Triple sequential diffusion

RATINGS	DTS 413	DTS 423
VOLTAGE		
V_{CEO}	400 V (Max)	400 V (Max)
V_{CEO} (Sus)	325 V (Min)	325 V (Min)
V_{CE} (Sat)	0.8 (Max)	0.8 (Max)
	0.3 (Typ)	0.3 (Typ)
CURRENT		
I_C (Cont)	2.0A (Max)	3.5A (Max)
I_C (Peak)	5.0A (Max)	10.0A (Max)
I_B (Cont)	1.0A (Max)	2.0A (Max)
POWER		
	75 W (Max)	100 W (Max)
FREQUENCY RESPONSE		
f_t	6 MC (Typ)	5 MC (Typ)

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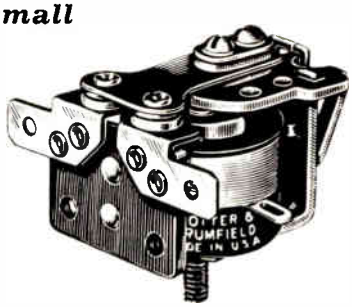
DELCO RADIO
Division of General Motors

Circle 29 on Inquiry Card

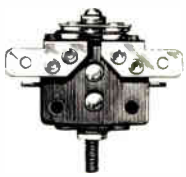
This P&B relay switches 20 amperes, costs only $3.90 each, is available from leading parts distributors...*

and it's this small



Here is a real space-saving power relay —ideal for applications where limited space is a factor. *Three* KR3 relays will fit in the space required for *one* 20-ampere relay of most other makes. The KR3 occupies only little more than one and a half cubic inches.

Installation is simple, too. Standard KR3 relays have a convenient stud and mounting tab—and the contact terminals will accept ¼" quick-connects or solder connections.



Field-proved for more than a year, the KR3 is available for immediate shipment from authorized P&B distributors. Tests show mechanical life will exceed one million operations . . . and the twin contacts are rated at 20 amperes at 115V AC, 60 cycles resistive or 28V DC, 1 HP 115/230V 60 cycles.

Relays ordered from the factory can be supplied in clear, high-impact polycarbonate case with octal plug.

For complete information, call your nearest P&B sales representative or write direct. Remember . . . you can buy cheaper relays but you cannot buy P&B quality for less.

ENGINEERING SPECIFICATIONS

GENERAL:

Insulation Resistance: 1000 megohms.
Expected Life: 1 million mechanical operations, min.
Breakdown Voltage: 500V rms 60 cycles bet. all elements.
Temperature Range, Open Relay: AC and DC: −45°C min. AC: +70°C max. DC: +85°C max.

CONTACTS:

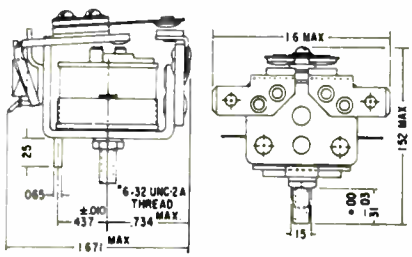
Arrangements: SPST-NO-DB (1 Form X) only.
Rating: 20 amps @ 115V AC, 60 cycles resistive, or 28V DC; 1 HP 115/230V 60 cycles.

COILS:

Voltage: DC: to 110V AC: to 230V
Power: DC: 1.2 watts min. AC: 2.0 volt-amps.
Resistance: 16,500 ohms maximum.
Duty: Continuous.

MOUNTING:

Open: One 6-32 stud and ¼" locating tab on 7/16" centers.
Enclosed: Octal socket.



**Unit price for 6 to 115V AC models. Quantity discounts available.*

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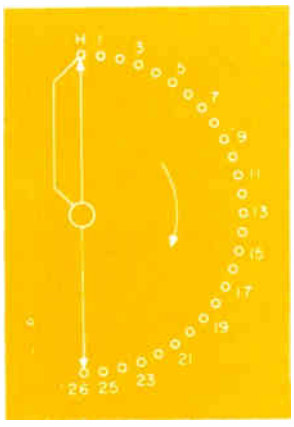
Division of American Machine & Foundry Company, Princeton, Indiana
In Canada: Potter & Brumfield, Division of AMF Canada Ltd., Guelph, Ont.
Export: AMF International, 261 Madison Avenue, New York, N.Y.



1965 Survey of Relay Specifications

Part 2: Stepping Relays & High Voltage Relays

Part 2 of EI's relay specifying guide surveys important characteristics of the various relays offered specifically for stepping and high voltage applications

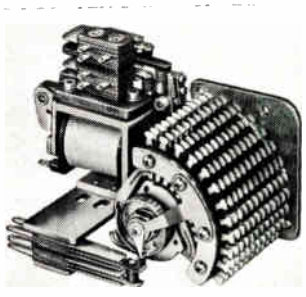
THE STEPPING RELAY, OR STEPPING SWITCH, is an electromagnetically actuated device. This distinguishes it from the manually operated rotary switch which is not covered in this survey.

Steppers are used to count, select, switch, indicate, scan monitor, time, control, test and program. Steppers in the "compact" family generally have from 10 to 132 contact points made up by anywhere from 1 to 12 levels, with 1 to 11 points per level. Larger switches provide 25 to 624 points. Any limitations on numbers of levels or contacts per level are easily overcome by use of additional steppers in the circuit. Contacts are commonly rated at 3 amps, but new switches are now available with contact capacities of 5 amps. Life spans range from 50 million to 250 million steps when operated self-interruptedly.

Basic Steppers

Stepping switches surveyed in this article are "hard" contact types. They are electrically operated, and stepped either by a relay or rotary solenoid through current pulses supplied externally or produced by self-interrupting contacts on the switch itself.

One basic type, the rotary stepper, employs rotating wiper contacts that successively engage fixed mating contacts mounted on insulating boards that make up a stationary bank or deck assembly. A second type, the cam switch or sequential relay as it is sometimes called, employs step rotating cams which mechanically operate spring action cantilever contacts. The number of contact points in the rotary stepper is determined by the number of levels and decks used, while for the sequential relay it is the number of cams used and the number of springs in the contact pile-up.



Model 211 offers 132 contact points in 12 11-point levels or five 33-point levels (Clare)

Direct and Indirect Drives

Either direct or indirect types of drive, as well as combinations of the two, are used in both the rotary stepper and cam switch. The direct drive mechanism performs the switching cycle the instant the energizing pulse is applied; while the indirect drive mechanism cocks the switch during the energizing pulse, and performs the switching function the instant the magnetic circuit is de-energized. Some switches combining the two drives for special versatility, rotate a half step when the coil is energized and complete the step when

ELECTRONIC INDUSTRIES STATE-OF-THE-ART FEATURE

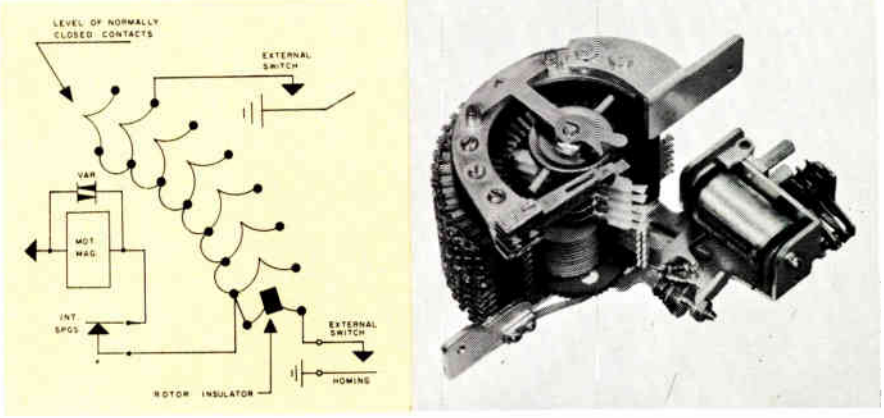
MORE ON RELAY SPECIFICATIONS WILL APPEAR IN THESE FUTURE ISSUES

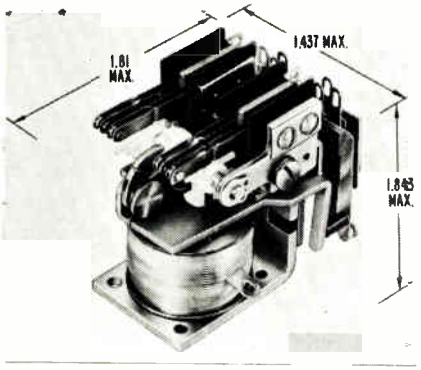
Part 3: POWER RELAYS—August 1965

Part 4: SPECIAL & G.P. RELAYS —Oct. 1965
(incl. Telephone and Subminiature Types)

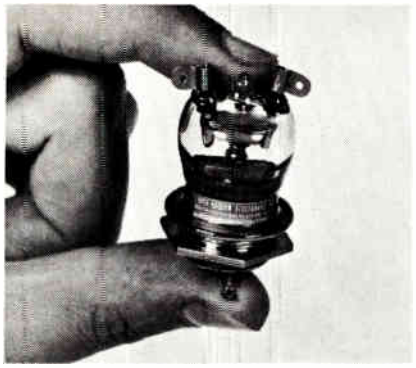
Part 1: REED RELAYS AND SENSITIVE RELAYS
(appeared in EI March, 1965 issue)

Self-interrupted stepping and homing of the Type 45NC stepping switch (Automatic Electric)

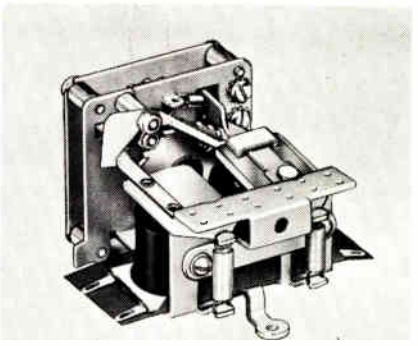




Impulse-sequencing relay with 2 or 4 sets of Form C contacts (Potter & Brumfield)



Stubby 1¾ in. vacuum relay switches 15 kvdc. Mfd. by High Vacuum Electronics



Model MER electrical re-set stepper claims a life of 5 x 10^6 steps (Guardian Electric)

STEPPER RELAY NOMENCLATURE

BIDIRECTIONAL — Contact wipers step in either direction, depending upon which of two coils is energized.

BRIDGING — Momentary shorting of adjacent contacts by wiper while advancing from one step to another (make-before-break action).

DECK—One insulating board containing a series of contacts arranged to engage wiping contacts at specified steps or positions. Also known as "bank." Each deck or bank may have one or more levels.

DIRECT DRIVE — Switching accomplished by magnetic action upon application of the energizing pulse.

INDIRECT DRIVE—Switching accomplished by spring action following application of the energizing pulse.

NON-BRIDGING—Transfer of circuits with a break-before-make action.

REVERSE MOTION RESET—A stepper that can be actuated to zero, or "home," from any position, in one reverse step.

ST/S—Abbreviation for steps per second.

UNIDIRECTIONAL — Contact wipers step in one direction only.

CAM SWITCH — Utilizes armature driven or spring driven ratchet assembly to operate cams which actuate contacts on cantilever springs.

STEPPING RELAYS (Continued)

de-energized. In the direct drive concept, power supplied to the coil is converted to force to advance the wipers, but in the indirect drive mechanism, force for advancing the wipers is supplied by a spring. Thus, the magnetic circuit supplies the driving force in the one case, and the force required to cock the drive spring in the other.

"Add-and-Subtract" Stepping

Rotary steppers can be unidirectional or bidirectional in operation. Unidirectional, continuous rotation types step in one direction, the wipers reaching "home" or starting position only after traversing all contacts. Bidirectional, "add-and-subtract" steppers utilize two coils and can be made to step in either forward or reverse direction at any time just by energizing either of the two coils. Some spring loaded bidirectional steppers employ a reset release coil which when energized provides very fast reset by causing the switch to fly back to the starting position in one large reverse step.

Information on Stepping Switches

The engineer with a need to become better informed about how to select, use and care for steppers has a wealth of information to choose from as contained in the catalogs of the stepping relay manufacturers. A few of these publications, which are usually available by writing to the manufacturer on your company's letterhead are listed here:

"Stepping Switches Manual 601" C. P. Clare.

"Steppers — Circuits and Selection Guide" Guardian.

"Industrial Catalog 64" Potter & Brumfield.

"How to Use Rotary Stepping Switches" Automatic Electric.

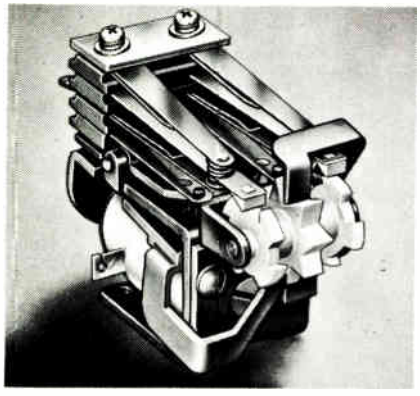
"Stepping Switches and Circuit Selectors" Ledex.

High Voltage Relays

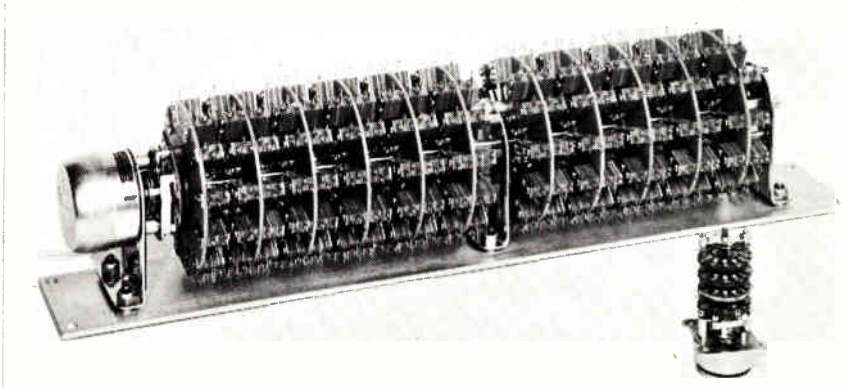
While high voltage relays are not recommended to replace circuit breakers, they sometimes offer savings in the no load control or transfer of high voltage, high frequency circuits. Applications include switching of RF pulse and power circuits,

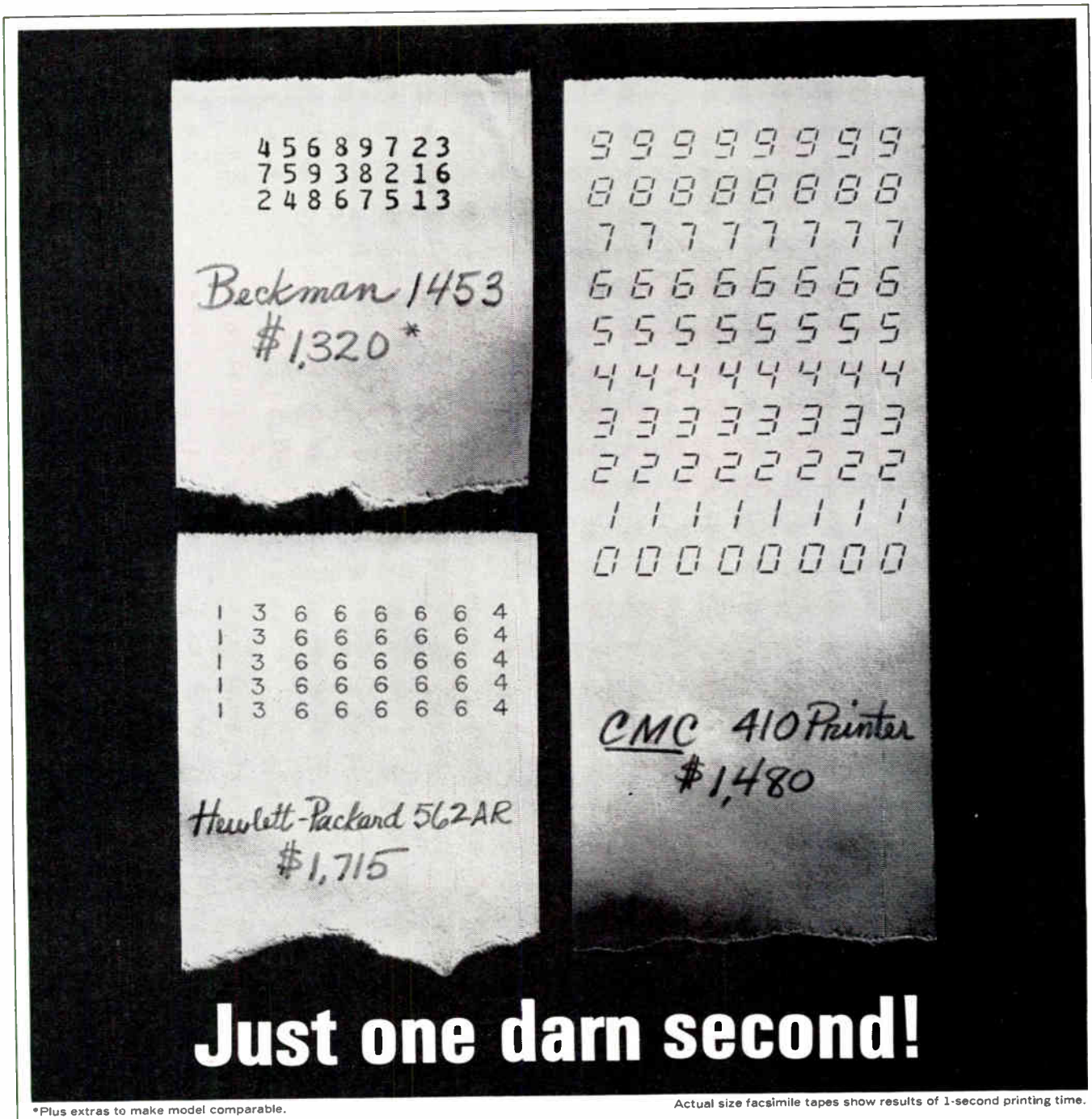
(*Continued on page* 166)

Relay with double cam (Struthers Dunn)



240-pole, 2-throw, switches 5 amps. at 115 vac. Predicted life — 50 x 10^6 steps (Ledex)





*Plus extras to make model comparable.

Actual size facsimile tapes show results of 1-second printing time.

Tear a piece of tape off all three big-name digital instrumentation printers. Compare speed and readability. One obviously prints at least twice as fast. Obviously one can be read without getting ink on your nose. One reason is, our new CMC 410 Printer is not just another rebuilt adding machine. Another reason: our logic conversion is all electronic. 35-millisecond data-gathering doesn't stall your source. The CMC 410 is quiet, compact (only half-rack size) solid-state, versatile, and all that. Our basic unit spews out 8-digit columns at 10 lines per sec. Column width expands to 12 digits. This new CMC 410 Printer is another step in our demoniacal plan to unseat some of the other big names in this business. Wait 'til you see what's next! Incidentally, we still have some of our glorious Crusading Engineer medals lying about. We'd sure be happy to send you this status symbol along with the specs for the new CMC 410 Printer. Just write and ask. If you already have a medal, pin this one on your secretary... or are you man enough?

CMC

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

ELECTRONIC INDUSTRIES

SPECIFICATIONS OF STEPPING RELAYS

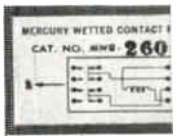
RELAY MANUFACTURER	TYPE NO. OR SERIES	AC OPERATED	DC OPERATED	CAM SWITCH	DIRECT DRIVE	INDIRECT DRIVE	IMPULSE TYPE	LATCHING	MERCURY WETTED	UNIDIRECTIONAL	REVERSE MOTION RESET	BIDIRECTIONAL	ROTARY SOLENOID	BRIDGING	NON-BRIDGING	SOLID STATE	NO. OF POLES	NO. OF DECKS	NO. OF STEPS/DECK	NOM. OPER. VOLTAGE	NOM. OPER. SPEED ST/S	MINIATURE	SUBMINIATURE	ENCASED	HERMETIC SEAL
ARTISAN ELECTRONICS CORP. 171 Ridgedale Ave. Morristown, N.J.	CS	X	X		X		X			X				X	X		1		2-12	to 110 DC to 230 AC	10			X	X
AUTOMATIC ELECTRIC CO. Northlake, Ill. 60164	40	X	X			X	X	X		X				X	X			5	10	to 110	to 65			X	X
	44	X	X			X	X	X		X				X	X			6,8	11	to 110	to 65			X	X
	80	X	X			X	X	X		X				X	X			6,12	10	to 110	to 65			X	X
	88	X	X			X	X	X		X				X	X			6,12	11	to 110	to 65			X	X
	45	X	X			X	X	X		X				X	X			2-12	26	to 110	to 65			X	X
	45	X	X			X	X	X		X				X	X			1-8	52	to 110	to 65			X	X
	OCS	X	X	X		X	X	X		X								1-8	36	to 110	65			X	X
	Minor				X		X				X				X		1,2	to 3	10		35				
	Strowger	X	X			X				X	X							to 3	100	48					
C.P. CLARE & CO. 3101 Pratt Blvd. Chicago, Ill. 60645	210	X	X			X	X	X		X				X	X			15	10	to 110	60			X	X
	210	X	X			X	X	X		X				X	X			11	20	to 110	60			X	X
	210	X	X			X	X	X		X				X	X			5	30	to 110	60			X	X
	211	X	X			X	X	X		X				X	X			15	11	to 110	60			X	X
	211	X	X			X	X	X		X				X	X			7	22	to 110	60			X	X
	211	X	X			X	X	X		X				X	X			5	33	to 110	60			X	X
	200	X	X	X		X	X	X		X				X	X			8	to 36	to 110	60			X	X
	20	X	X			X	X	X		X				X	X			12	40	to 110	60			X	X
	20	X	X			X	X	X		X				X	X			16	20	to 110	60			X	X
	26	X	X			X	X	X		X				X	X			12	52	to 110	60			X	X
	26	X	X			X	X	X		X				X	X			16	26	to 110	60			X	X
	Direct Drive	X	X		X		X							X	X			3	10	to 110	30			X	X
CORNELL-DUBILIER ELECTRONICS DIV. 118 E. Jones St. Fuquay Springs, N. C. 27526	1450	X	X	X	X		X	X		X					X		5	Form A	12	6-220	40			X	X
	1403	X	X	X	X		X	X		X							5	Form A	12	6-220		X		X	X
	1451	X	X	X	X		X	X		X							6	Form C	12	6-220				X	X
FISHER AKIN CO. 1005 Sepulveda Blvd. Manhattan Beach, Calif.	–		X			X	X		X						X	X					24-32					
GUARDIAN ELECTRIC MFG. CO. 1550 W. Carroll Chicago, Ill. 60607	MC	X	X		X		X	X		X				X				1,2	24	230	30				
	PC	X	X		X		X	X		X				X	X			3	24/40	230	30				
	RC	X	X		X		X	X		X				X				1,2	52	230	10				
	MER	X	X		X		X				X			X				1,2	24	230	25				
	PER	X	X		X		X				X			X	X			1,2	24/40	230	25				
	RER	X	X		X		X				X			X				1,2	52	230	10				
	RAS	X	X		X		X					X		X	X			to 3	to 52	230	15				
	705	X	X		X	X					X				X			1	12	230	30		X		
							(continuous duty coils)																		
	MAS	X	X		X		X					X					2	(Form A, B, C)		230	25				
	120/125	X	X	X	X												to 4			230	10				
	660/665	X	X	X	X		X										to 4			230	10				
HURLETRON, INC. Whittier, Calif.	–	X	X		X	X	X			X	X	X	X				to 12	to 8	2-12	to 230			X	X	X

Adlake makes more kinds of mercury relays than anybody*

You name it! Adlake has: time delay; load (contacts open or closed); wetted contact (including epoxy and encapsulated, polarized and sensitive or bi-stable—plus high speed modules with variable front and back dimensions). For complete information, contact Adlake direct.

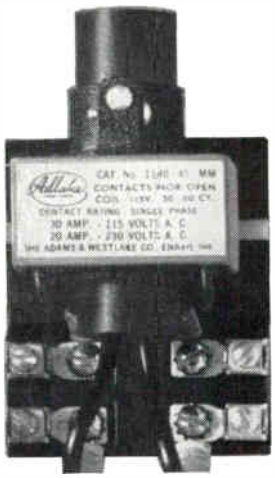
*Send for a free Adlake catalog today!

BE SURE TO VISIT BOOTH 4125 AT THE DESIGN ENGINEERING SHOW



Adlake®
RELAYS

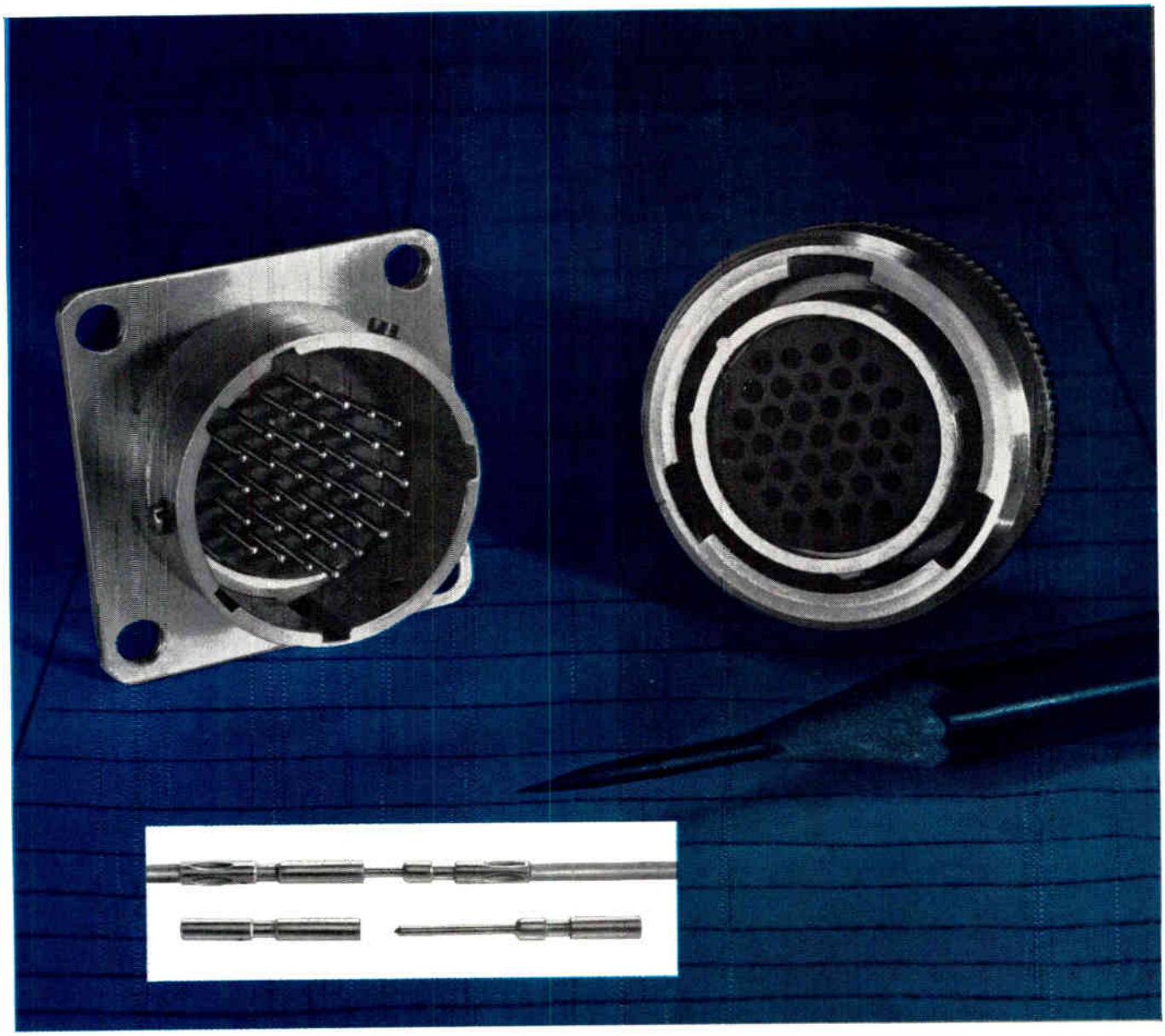
The Adams & Westlake Co.
Dept. R-8805, Elkhart, Indiana
Area 219 COngress 4-1141



ELECTRONIC INDUSTRIES

STEPPING RELAYS (Cont.)

RELAY MANUFACTURER	TYPE NO. OR SERIES	AC OPERATED	DC OPERATED	CAM SWITCH	DIRECT DRIVE	INDIRECT DRIVE	IMPULSE TYPE	LATCHING	MERCURY WETTED	UNIDIRECTIONAL	REVERSE MOTION RESET	BIDIRECTIONAL	ROTARY SOLENOID	BRIDGING	NON-BRIDGING	SOLID STATE	NO. OF POLES	NO. OF DECKS	NO. OF STEPS/DECK	NOM. OPER. VOLTAGE	NOM. OPER. SPEED ST/S	MINIATURE	SUBMINIATURE	ENCASED	HERMETIC SEAL
IMTRA CORP	–									X				X	X			11	25		65				
11 University Rd.	–									X				X	X			6	50		65				
Cambridge 38, Mass.	–			X			X			X								12	30		80	X			
(U.S. Agent for General Electric Co., Ltd.)	–			X			X			X									36		36				
	–						X					X		X	X				25		65				
JENNINGS RADIO MFG. CORP.	RN3		X	(40 kv vacuum relay)						X			X				1	1	6	30A to 115					X
970 McLaughlin Ave.																									
San Jose, Calif. 95108																									
LEDEX, INC.	250	X	X				X					X	X		X		3	4	4	28/115	28				X
123 Webster St.	250	X	X				X					X	X		X		2	5	6	28/115	28				X
Dayton 2, Ohio	250	X	X				X					X	X		X		1	3	10	28/115	12				X
	250	X	X				X					X	X		X		1	7	10	28/115	12				X
	250	X	X				X					X	X		X		1	4	12	28/115	28				X
	250	X	X				X					X	X		X		1	9	12	28/115	14				X
	250	X	X				X					X	X		X		1	4	18	28/115	10				X
	250	X	X				X					X	X		X		1	9	18	28/115	10				X
	250	X	X				X					X	X		X		1	4	24	28/115	10				X
	250	X	X				X					X	X		X		1	9	24	28/115	12				X
	–	X	X				X					X	X							28/115	30		X		X
	5–10019–041		X				X					X	X				4	3	2	28/115	30		X		X
	5–10019–040		X				X					X	X				2	3	4	28/115	30		X		X
	5–10019–039		X				X					X	X				2	3	6	28/115	30		X		X
	5–10019–004		X				X					X	X				1	3	12	28/115	30		X		X
POTTER & BRUMFIELD	PA	X	X	X	X		X	X		X					X		(4 Form C)			to 230				X	X
1200 E. Broadway	PC	X	X	X	X		X	X		X					X		(4 Form C)			to 230				X	X
Princeton, Ind.	SA	X	X		X		X	X		X					X		1	1	12	to 230				X	X
	GM	X	X	X		X	X	X		X					X		2,4		10,12	to 230				X	
	GML	X	X	X	X		X	X		X					X		(4 Form C)			to 230				X	
SCHRACK ELECTRICAL SALES CORP.	RT304		X	X			X								X		1	4	12	to 110	65				
1140 Broadway,	RT404		X				X								X		1	4	10	to 110	65				
New York, N.Y. 10001																									
STRUTHERS-DUNN, INC.	211	X	X	X	X	X	X	X		X				X	X		2	1	6,8	to 230				X	X
Lambs Rd.	B11	X	X	X			X	X		X							2	1	to 12	to 230		X		X	
Pitman, N.J.	C85	X	X				X	X		X							2	1	to 12	to 550				X	
	95	X	X		X		X	X		X							12	1	to 12	to 550					
	96	X	X	X			X	X			X						12	1	to 12	to 550					
	99	X	X	X	X		X	X			X						12	1	to 8	to 550					
TELE-NORM CORP.	–																	6	12						
32-31 57th St.	–																	4	18						
Woodside, N.Y. 11377																									
TELERAD MFG. CO.	4175		X								X						1		4,6,12	3W					
Hoffman Pl.	4176	X															1		4,6,12	3W					
Hillside, N.J. 07205	4177	X									X						1		4,6,12	3W					
	4178		X														1		4,6,12	3W					



Designed with space in mind

Fresh from our drawing boards and as new as the lunar probe is this A-MP* subminiature circular pin and socket connector. It gives you *over twice the number of contacts* available in conventional connectors of the same size. Compare the contact density of our subminiature connector with any MIL-C-26482 or 26500 type miniature connector and you'll see how "space conscious" our designers really were:

Shell Size	Contacts A-MP Subminiature Connector	Contacts Conventional Min. Connectors
18	85	32
16	58	26
14	37	19
12	26	10
10	14	6

All A-MP contacts have a .030" pin diameter and accommodate wire ranges 22-24 and 26-30 AWG. The contacts are gold over nickel plated and are terminated with a new four indent crimping tool.

Within the design parameters established for the A-MP subminiature circular connector was the elimination of the failure modes encountered in conventional miniature circular connectors. This was accomplished by providing a hard face insert to promote accurate contact alignment and stability; stainless steel shells with positive shell keying and bayonet coupling; the elimination of contact retention clips; a rear guide plate to protect the rear grommet from contact insertion damage; probe proof closed entry sockets; positive contact bottoming in a hard dielectric insert and a choice of front or rear contact extraction without a retention release tool.

In addition, this uniquely engineered connector is designed for all environmental conditions encountered by ground support, aircraft, missile and space applications.

Take a count down of these other space age features:

- Temperature range: −55°C to +150°C
- Altitude—110,000 feet
- Stainless steel shell provides shielding and continuous grounding.
- Retention value: 15 pounds per contact.

AMP's subminiature circular pin and socket connector is tomorrow's answer to your connector problems and it's available today! Write for complete information.

*Trademark of AMP INCORPORATED

AMP INCORPORATED
Harrisburg, Pennsylvania

INDUSTRIAL SALES DIVISION

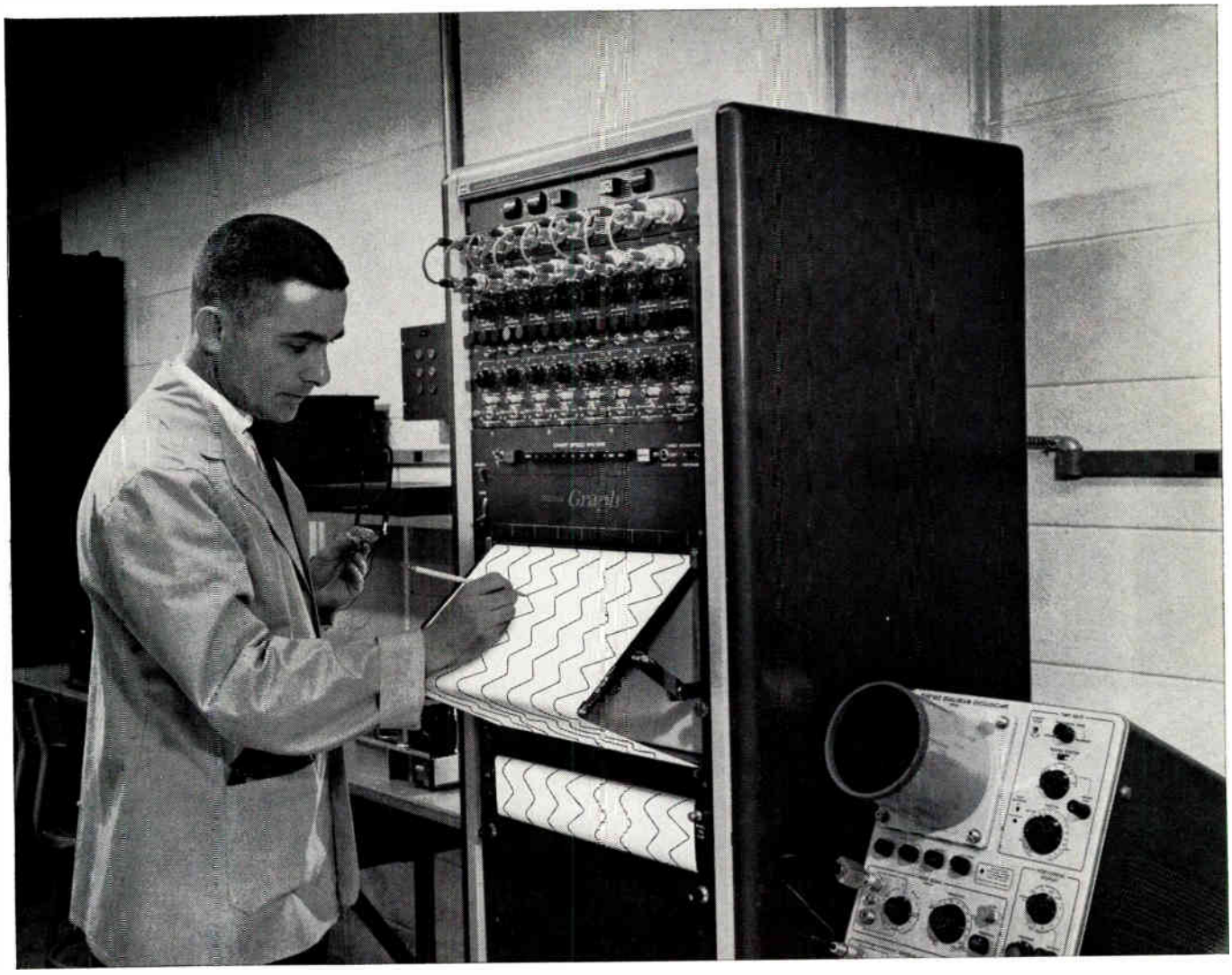
A-MP* products and engineering assistance are available through subsidiary companies in: Australia • Canada • England • France • Holland • Italy • Japan • Mexico • West Germany

Circle 67 on Inquiry Card

ELECTRONIC INDUSTRIES

SPECIFICATIONS OF HIGH VOLTAGE RELAYS

RELAY MANUFACTURER	TYPE NO. OR SERIES	AC OPERATED	DC OPERATED	ANTENNA CHANGEOVER	MOTOR DRIVEN	PULSE SWITCH	RF SWITCH	VACUUM RELAY	NO. OF POLES	CONTACT FORM	NOM. CONTACT VOLTAGE (KV)	NOM. CONTACT CURRENT (A)	NOM. CONTACT POWER (KW)	NOM. OPER. TIME (SECS)	NOM. COIL VOLTAGE (V)	NOM. COIL VA	MINIATURE	ENCASED	BASE OR BRACKET MTG.	THREADED MTG.	MIL-R-5757 SPEC.	HERMETIC SEAL
HIGH VACUUM ELECTRONICS 541 Mission St. S. Pasadena, Calif. 91030	H5/7		X			X		X	1	SPST	5	2		.0005	24		X		X		X	
	H8		X			X	X	X		SPDT	20	15			26					X	X	
	HVS3		X			X	X	X		SPDT	20	10		.02	115						X	
	HVS10		X			X		X		SPDT	17	350			40				X		X	
	H14		X					X		DPDT	20	10		.018	26					X	X	
	HVS1		X			X		X		SPDT	17	7		.02	28				X		X	
	HVS6		X			X		X		SPDT	10	5		.02	115						X	
	H35		X			X		X		SPDT	35	10		.03	28				X		X	
	H12		X					X		SPDT	12	15		.018	26					X	X	
	H11		X					X		SPST	12/15				26							
	HVS4		X					X		SPDT	17	8			24							
	H16		X			X		X	2	DPDT	12KV	15		.015	26				X	X		
	H17		X			X		X	1	SPDT	25KV	25		.015	26				X	X		
INDUSTRIAL INSTRUMENTS, INC. 89 Commerce Rd. Cedar Grove, N.J.	15HV-SPDT	X	X						1	SPDT	15	5		.05	24/115			X				X
	10HV-DPDT	X	X						2	DPDT	10	2		.05	24/115			X				X
	10HV-3PDT	X	X						3	3PDT	10	2		.05	24/115			X				X
JENNINGS RADIO MFG. CORP. 970 McLaughlin Ave. San Jose 8, Calif.	RA1-4		X			X	X	X	1-4	DT	0.3	to 100		.025	26/115				X		X	
	RB7		X			X	X	X	2	DT	7	14		.015	26/115				X		X	
	RB1		X			X	X	X	1	DT	12	15		.018	26/115				X		X	
	RB2		X			X	X	X	2	DT	20	20		.020	26/115				X		X	
	RB3		X			X	X	X	2	DT	12	30		.020	26/115				X		X	
	RB4		X			X	X	X		DT	12	20		.045	26/115				X		X	
	RD5,6		X			X	X	X	1	ST	12	15		.018	26/115				X		X	
	RE6B		X			X	X	X	1	DT	25	25		.025	26.5				X		X	
	RS8,10		X			X	X	X	1	ST	28	75		.030	26.5					X		
	RF10A		X			X	X	X	1	DT	15	60	64	.018	26.5				X			
	RJ1A		X	X		X	X	X	1	DT	3	20	7	.008	26.5		X			X		
	RN3		X	X		X	X	X	1	6T	20	30		.035	26.5				X			
JOSEPH POLLAK CORP. 81 Freeport St. Boston 22, Mass.	RL906		X			X			2	DTDB	10	1			6-120						X	
	RL1007		X			X			1	DTDB	10	1			6-120						X	
	RL1011		X			X					10	5										
	RL904		X			X					20	1										
STRUTHERS-DUNN, INC. Lambs Rd. Pitman, N.J.	190XDX100	X					X		4	DT	14								X			
	8BXX229		X				X		4	ST	1.5								X			
	10XBX123	X	X	X			X		2	DT	.5								X			
	90XXM100	X					X		3	ST	7.5								X			
	78CCA101	X	X				X	X	5	DT	9.2								X			
	90HXX111	X							1	ST	5								X			
	–				X		X		1	DT	45								X			
TELEX/AEMCO DIV., TELEX, INC. 10 State St. Mankato, Minn.	51	X	X	X			X		2	DT		10	1		12-110	6.9						



110 cps full scale response + greatest resolution = your best Oscillo Graph buy

No other oscillograph recorder can match the frequency response of Esterline Angus . . . flat to 110 cps (±1%) at 40 mm peak-to-peak deflection.

At 140 cps, frequency response of these four, six and eight channel recorders is down only 3 db from full scale. Even at 200 cps, stylus excursion is 8 to 10 mm.

Resolution? Esterline Angus combines highest chart speeds (to 500 mm per second) with highest frequency response.

Exceptional resolution is further assured because of the exclusive Direct-Carbon-Transfer writing method. Even the one, two and three channel portables feature this inkless and heatless writing method. Advantages of D-C-T?

- 0.005 inch wide trace occupies only ½% of full scale. Traces of competitive oscillographs are three times wider.
- Chart paper at half the cost of heat sensitive paper. Charts can be easily, economically reproduced.
- No start-up problems because there are no pens to clog or ink to splatter.
- No stylus temperature adjustments to bother with.

Interchangeable, plug-in amplifiers and couplers provide a multitude of signal channels to record signals from a few microvolts to hundreds of volts.

The stylus motor uses no permanent magnets. This eliminates the clutter of brushes, slip rings, armature leads and linkages normally found in stylus drive mechanisms.

For highest resolution, unequalled response and trouble-free writing, investigate Esterline Angus Oscillo Graph Recorders.

Write for informative Series "O" Catalog.

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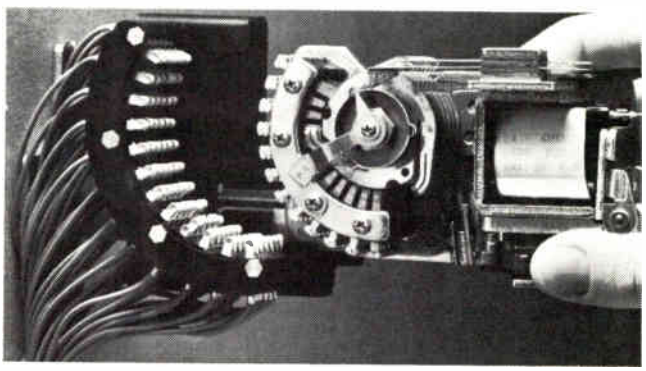
WHAT ARE SENSITIVE RELAYS?

TO THOSE READERS WHO HAVE ASKED what standards were used in compiling the "sensitive" relays which appeared in the March issue, the listing was intended to group relays with power sensitivities below 200 milliwatts, a purely arbitrary limit since there is nothing in the literature or terminology that defines a sensitive relay. (Note: The U. S. Department of Commerce, Washington, D. C., in their Quarterly Survey of Production Capabilities for Electronic Parts groups clapper type relays above and below 100 milliwatts.) It should be pointed out, however, as stated in the article, that several manufacturers are merchandising groups of their relays as "sensitive" types even though the coil power ratings are higher than 200 milliwatts. It should also be pointed out that relays listed under "reeds" or other categories might logically fit the description of our "sensitive" relays. To list them in both groups, however, would cause space consuming duplication.

STEPPING SWITCH CONNECTOR

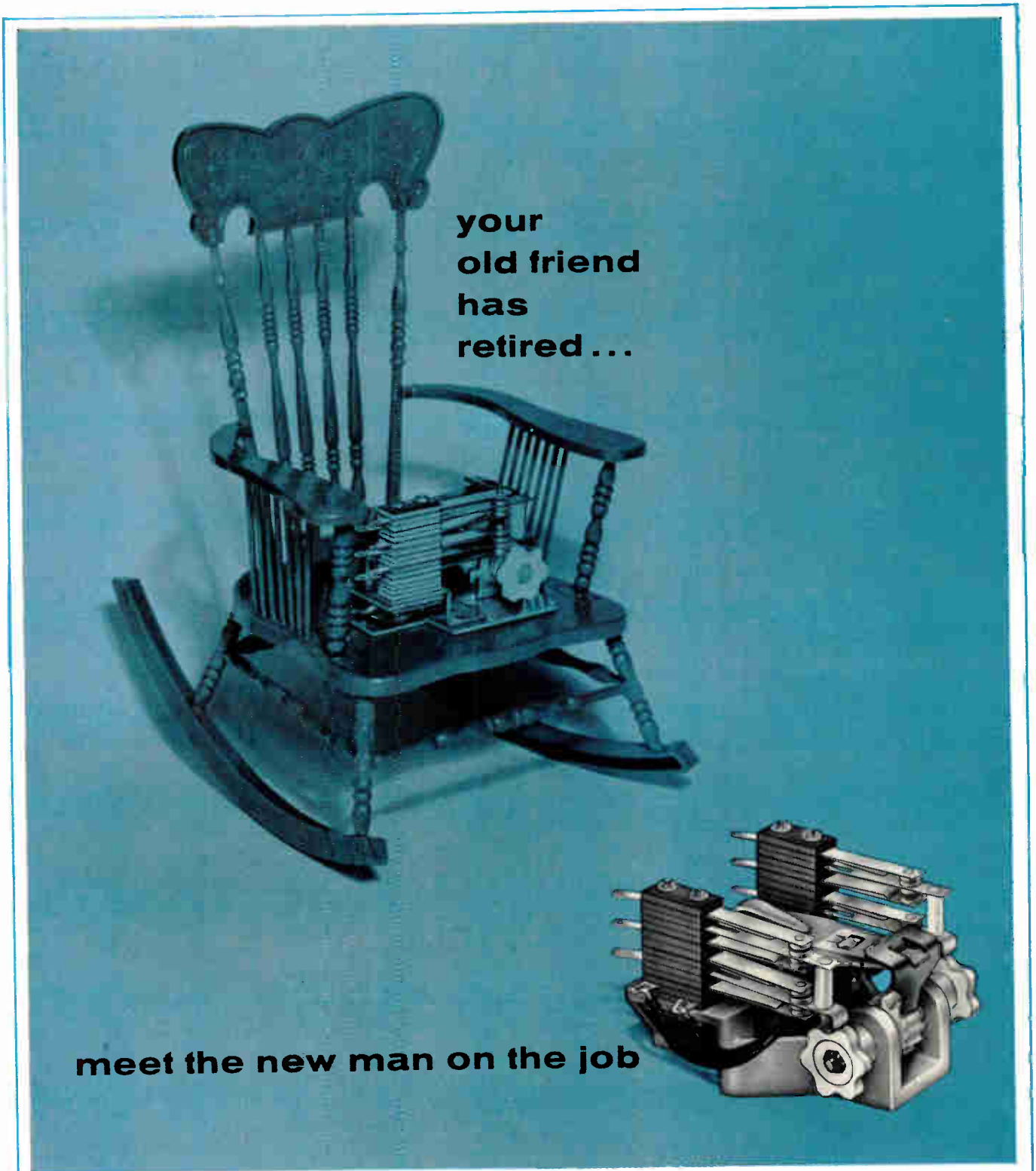


New AMP Inc. connector converts stepping switch into plug-in component. Crimp-on, snap-in contacts permit easy insertion of leads.

A STEPPING SWITCH CONNECTOR that converts a standard stepping switch into a plug-in component is one of the newest items produced by AMP, Inc. The connector is much like the stepping switch in construction; each level of contact springs is held between laminations assembled in banks corresponding in thickness to the stepping switch.

Contacts can be crimped by automatic machine, by hand tool onto individual leads or on wire harness. Contact reliability is assured by redundant contact areas plated with tin or gold over nickel. A positive guide aligns the contact of switch and connector. The snap-in connector fits most standard stepping switches.

The connector has a minimum breakdown voltage between 1000 and 2000vac, insulation resistance of 10^{11} ohms minimum at 500vdc, plus a current rating of 3a. continuous.



The predecessor to our new series 660 sequential relay served you well and faithfully. But change comes, as it does to all good things, and the new relay on the job is even longer-lived and more reliable. ■ Just about everything is new—except the low price. This relay is now built with a heavy cast aluminum base, so it can't flex out of adjustment when you fasten it down on an uneven surface. We've improved the detent, increased contact travel and even redesigned the cams. Just as important, we've balanced the bearings, cams and drive mechanism, so you get more work for the same power. That's why the new relay accommodates more switches—up to 4PDT. ■ We could talk all day about improvements, but the important thing to remember is that you can't do better than this new series 660 relay for sequential switching of loads up to 12½ amps. Five standard and a full range of special cams make or break a series of circuits in virtually any required order at up to 10 cycles per second. ■ Send for our new series 660 spec. sheet that shows how versatile this unit really is. Guardian Electric Manufacturing Co., 1550 West Carroll Avenue, Chicago, Illinois 60607. Dept. EI 55.

GUARDIAN® ELECTRIC

The AE Type 45 Rotary Stepping Switch can solve almost any circuit-transfer problem

There's an economical, rugged and reliable way to simplify many of today's complex switching circuits. Just replace entire groups of relays or transistors with an AE Type 45 "stepper." One of these large-size, general-duty rotary stepping switches can provide up to twelve 25-point bank levels, or up to eight 50-point bank levels.

Choose between the Type 45 (with normally open levels) or the Type 45NC (with normally closed levels). The latter is designed so that, when the rotor is stepped, pairs of bank contacts are *opened* successively. For true versatility, NO and NC levels can be combined on the same switch!

When you specify AE rotary stepping switches you get the benefit of continuous research—in design, in metals and insulating materials. Plus *positive positioning*, a unique AE design feature that locks the rotor, makes overthrow impossible.

For helpful application information, we offer the 160-page book, "How to Use Rotary Stepping Switches." To get your copy, just ask your AE representative. Or write the Director, Relay Control Equipment Sales, Automatic Electric, Northlake, Illinois 60164.

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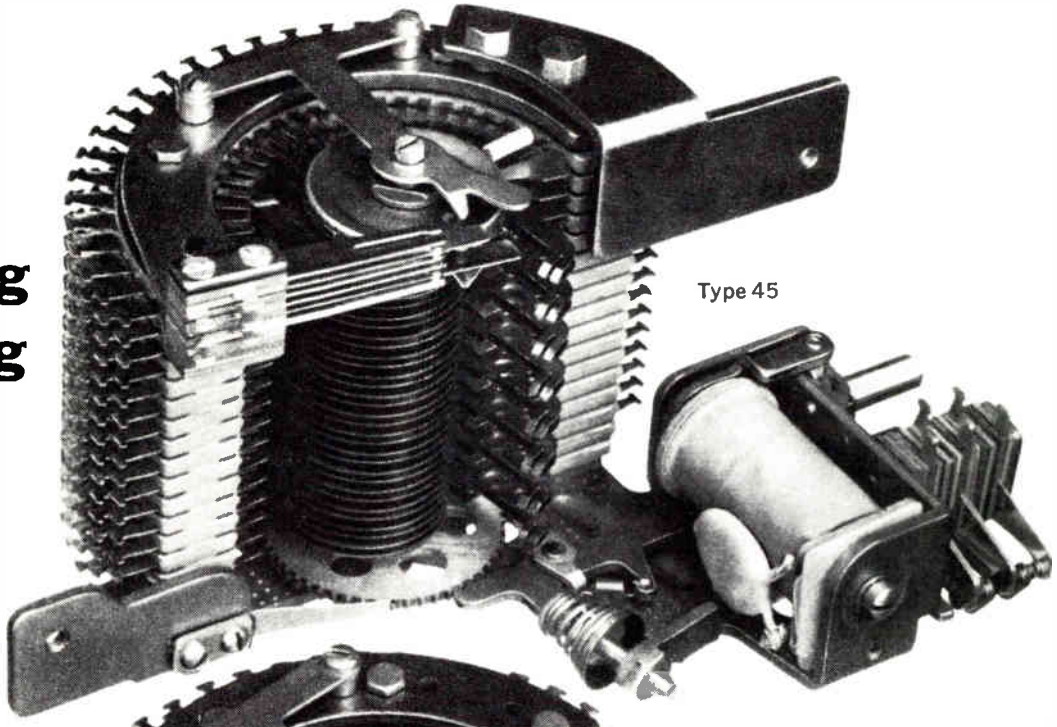
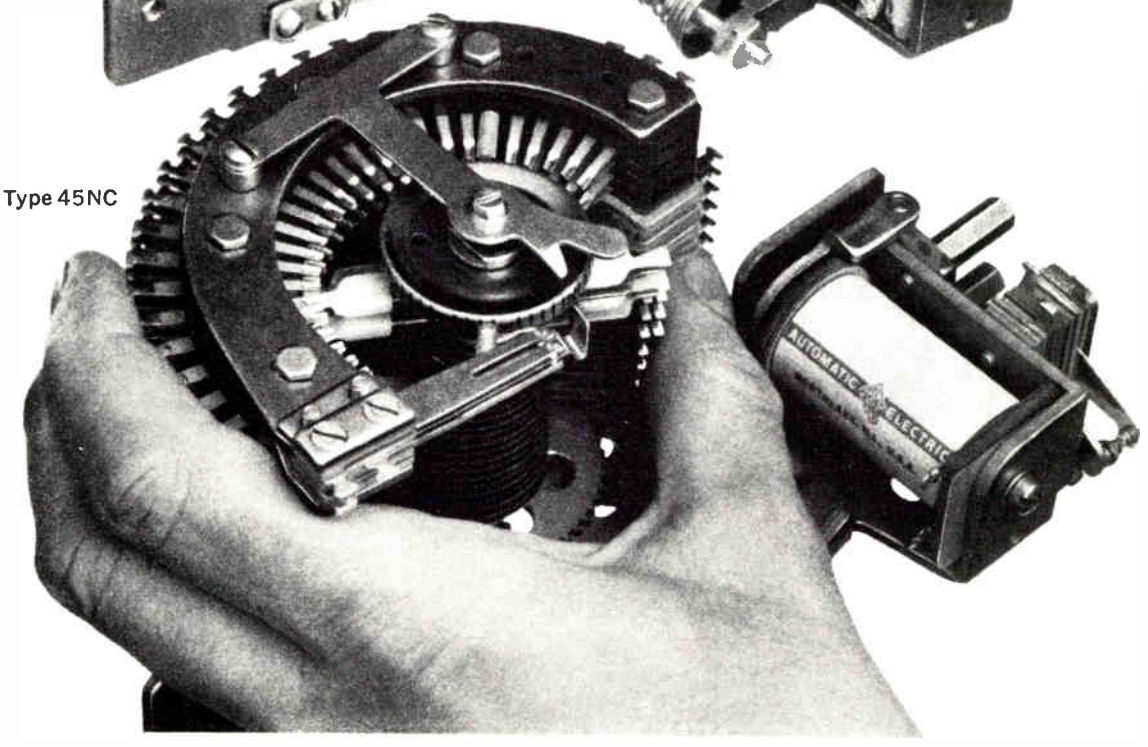
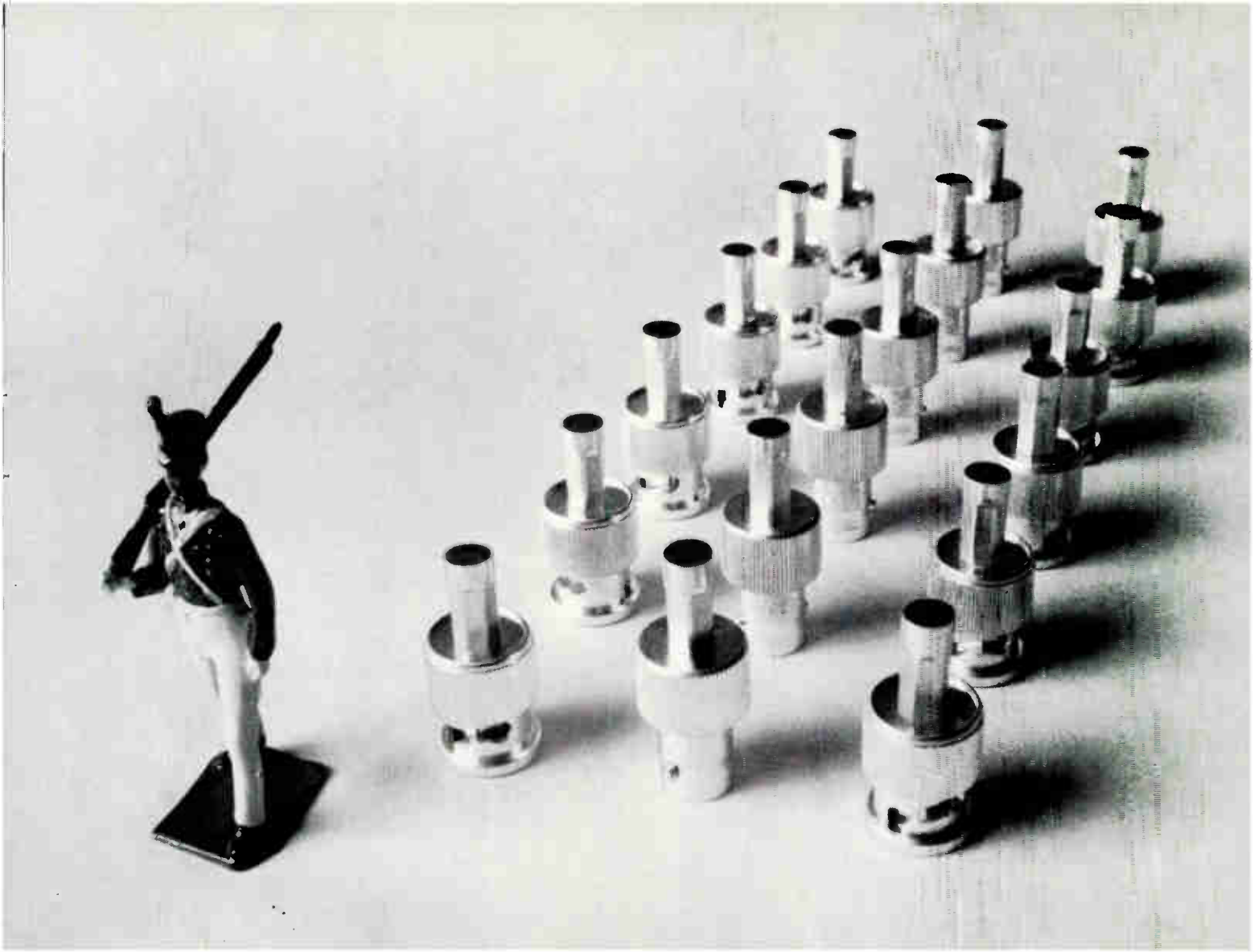


Type 45



Type 45NC



Amphenol quick-crimp coaxial connectors go military

Now you can have your MIL-spec and crimp it, too! Until now you've had to put up with clamp and solder type UG connector substitutes for MIL-C-23329A.

FIRST CONNECTOR TO MEET MIL-C-23329A. This is Amphenol's new *"MIL-Crimp"** coaxial connector—in a complete line of plugs, angle plugs, jacks, and bulkhead jacks. It actually exceeds the requirements of the MIL-spec.

IMPROVED PERFORMANCE. Laboratory and field data show that this connector's VSWR is held to just 1.2 to 10 GHz. Cable pull-off strength exceeds 90 lbs. (the braid breaks first), compared to the 70 lbs. specified to MIL-C-23329A (or to.35 lbs. for most UG connectors). Center contact is completely captivated for maximum electrical, mechanical stability.

CUTS COSTS BY 1/3. No soldering. No combing of braid. No washers or tiny parts. The assembler just pokes on the center contact, slips on the connector body and ferrule, and crimps. Any assembler can terminate a coaxial cable with an Amphenol quick-crimp connector in 30 seconds. (Average time for regular solder and clamp termination is 5 minutes per connector.) One manufacturer of telemetry gear figures he will save almost enough in reduced assembly costs to pay for his connector purchases.

IMMEDIATE DELIVERY. Here are two ways to get fast delivery: (1) Ask your Amphenol Sales Engineer. (2) Check with your local Amphenol distributor.

Or write: Amphenol RF Division, 33 East Franklin Street, Danbury, Connecticut 06813.

*Trade Mark

Amphenol® RF DIVISION

AMPHENOL-BORG ELECTRONICS CORPORATION

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

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New products from TI to help you

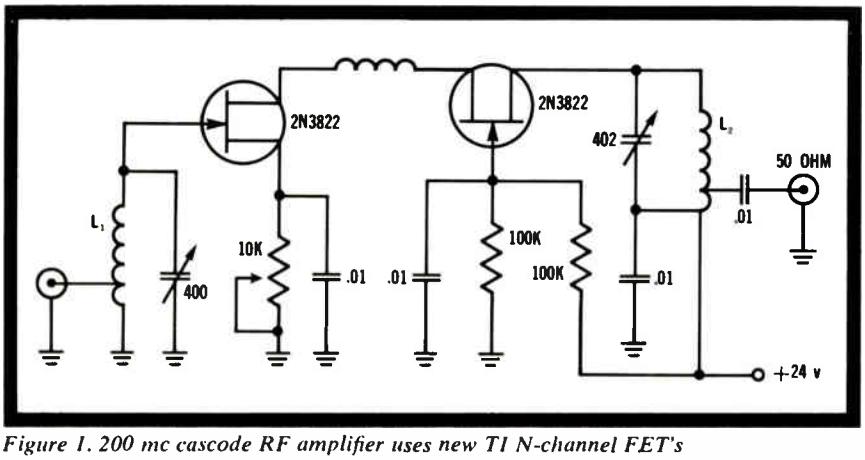


Figure 1. 200 mc cascode RF amplifier uses new TI N-channel FET's

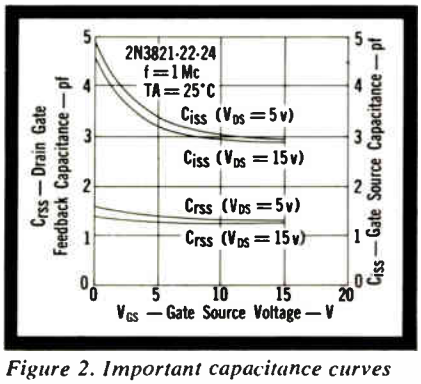


Figure 2. Important capacitance curves for 2N3821, 22, 24 transistors

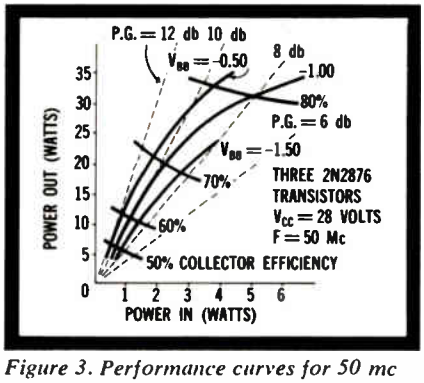


Figure 3. Performance curves for 50 mc amplifier shown in Figure 4

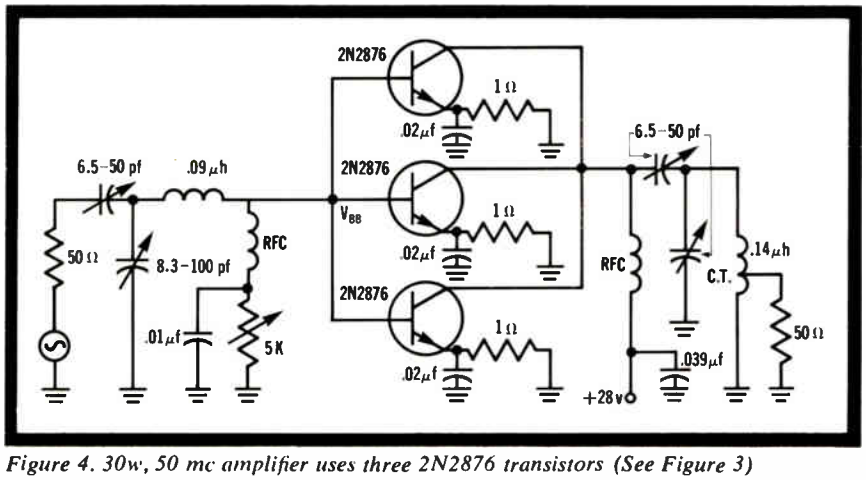


Figure 4. 30w, 50 mc amplifier uses three 2N2876 transistors (See Figure 3)

N-channel FET's provide low-noise amplification beyond 200 mc

You can improve RF amplifier performance by using new TI N-channel field-effect transistors. Two 2N3822's used in the 200 mc cascode amplifier shown in Figure 1, gave 12 db gain and only 2.2 db noise at 200 mc. Cross modulation was less than *one percent* when a 1000 μv, 200 mc signal and a 200,000 μv, 150 mc signal were combined.

The new series, numbered 2N3821, 22 and 24, offers y_{fs} as high as 4500 min at 100 mc. Noise figure is typically 3 db at 10 cps. Gate leakage is typically 10 picoamps, and maximum input capacitance is less than 6 pf. Other advantages include zero offset voltage (in chopper applications) and high input impedance.

Dual N-channel FET's, typed TIS25-27, are available in a low-profile TO-5 package.

Circle 120 on the Reader Service Card for data sheet.

5 db gain at 150 mc, 10 watts output at 50 mc from new TI silicon transistors

High efficiency and high power output are characteristics of two silicon planar epitaxial power transistors from TI. As shown in Figure 4, they may be paralleled for even higher output.

JEDEC registered as 2N2876 and 2N2631, the new transistors are available in an isolated 7/16-inch stud package and a short-lead TO-5 respectively. Power output for the 2N2876 is 10 w at 50 mc and 3 w at 150 mc. The 2N2631 is rated 7.5 w at 50 mc and 3 w at 150 mc.

Applications include military communications equipment, SonoBouys, citizens band transmitter driver or output stages up to 200 mc, and high-speed switching up to 2 amps.

Circle 121 on the Reader Service Card for data sheet.

Double-anode regulators reduce cost of transient protection

New one-watt, double-anode TI regulators provide zener regulation in both forward and reverse direction yet are priced competitively with single-anode units. Result: a sharp reduction in circuitry costs in many applications, such as the one shown in Figure 5.

For both forward and reverse transient protection and bidirectional clipping applications, one double-anode regulator replaces two single-anode units, reducing component cost, simplifying circuitry and reducing parts inventories. The new devices also can be used in both for-

TI cannot assume any responsibility for any circuits shown or represent that they are free from patent infringement.

ward or reverse single-anode applications at no cost penalty.

The new TI regulators, designated 1N4831-60, are rated from 9 to 150 v. Other characteristics include a sharp zener "knee", low dynamic impedance, and an operating temperature range of −65° to 175°C. They are packaged in a fully insulated, cylindrical glass package that measures only 0.150 by 0.360 inches.

Circle 122 on the Reader Service Card for data sheets.

New gated symmetrical switch permits simpler control circuits

Now you can cut circuitry essentially in half by using a TIC20-23 silicon gated symmetrical switch instead of two conventional SCR's.

These new full-wave devices feature high voltage capability (to 300 v), high power capability (600 w, 1500 w peak), and high current capability (6 amps below 75°C). Gated operation reduces RF interference.

Circuits, such as the light dimmer circuit shown in Figure 6, provide 5 to 95 percent a-c power control with a single device. The TIC20-23 series may also be used in high-sensitivity phase control circuits.

The gated switches are available in either an automotive press fit package or a ¼-inch stud package. Circle 123 on the Reader Service Card for data sheet.

New picosecond switching diodes

Recovery times of less than 100 psec, offset voltage V_F=0.3 v typical at 0.1 ma, and high reliability are among features of TIXD27-28 switching diodes announced by TI.

Extremely high speed and high conductance at low voltage and current make these new devices ideal for demanding application such as the oscilloscope sampling circuit shown in Figure 7.

Reliability studies on the new units indicate that metal-silicon barrier diodes give exceptional reliability and uniformity of parameter.

Circle 124 on the Reader Service Card for data sheets.

Noise figure for new UHF mixer diode is 10 db typical at 890 mc

The new TIXV304 metal-silicon barrier mixer diode makes possible low-noise UHF TV front ends with exceptionally uniform characteristics.

The metal-silicon barrier construction makes possible better circuit performance and higher reliability at no price penalty over older point contact devices.

The TIXV304 is packaged in the proven *Moly/G*® diode package. Circle 125 on the Reader Service Card for data sheet.

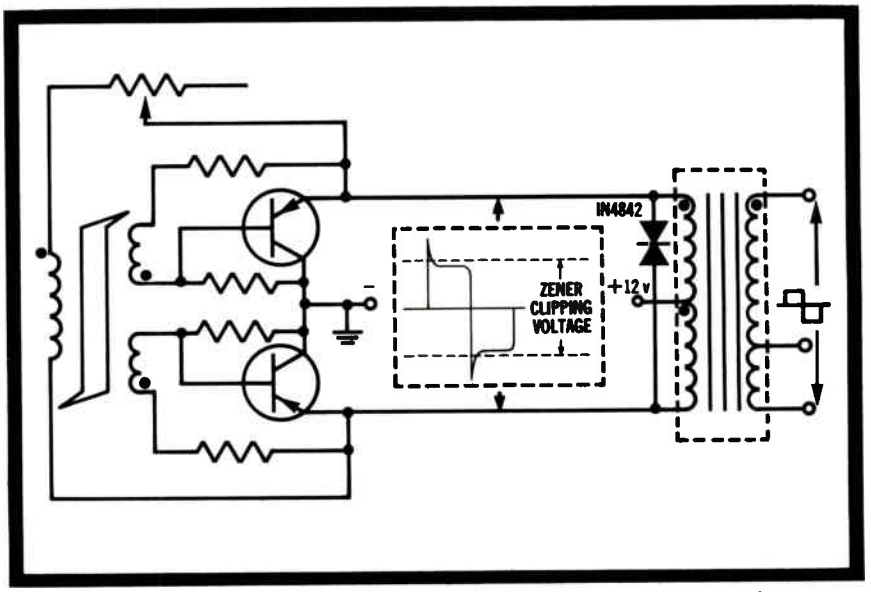


Figure 5. One 1N4842 double-anode regulator protects both transistors by clipping transients in this dual-transformer inverter

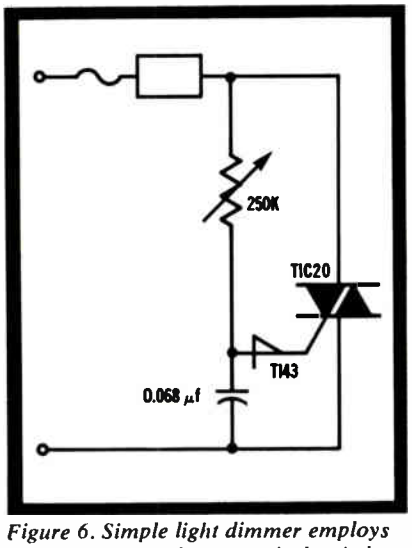


Figure 6. Simple light dimmer employs TI gated symmetrical switch

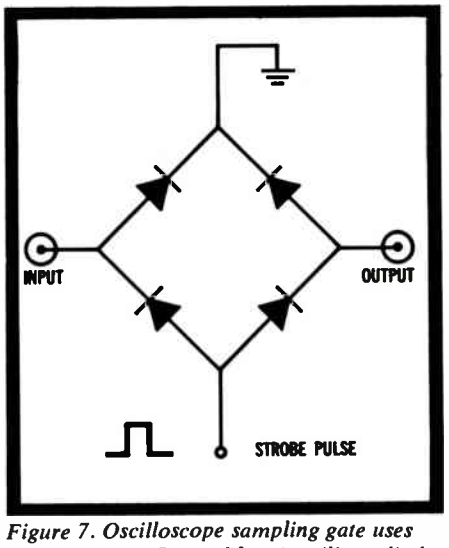
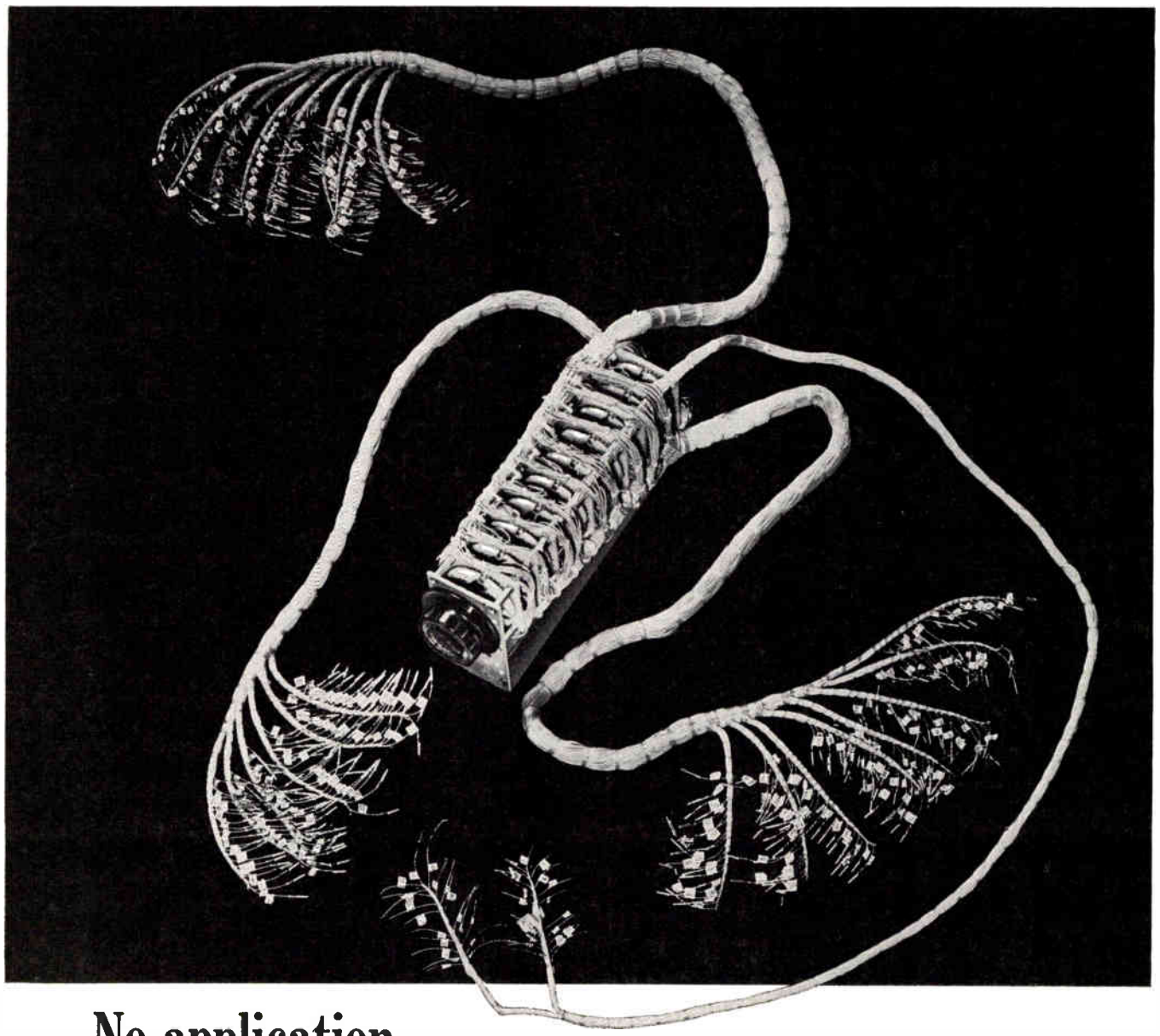


Figure 7. Oscilloscope sampling gate uses TIXD27 metal-barrier silicon diodes



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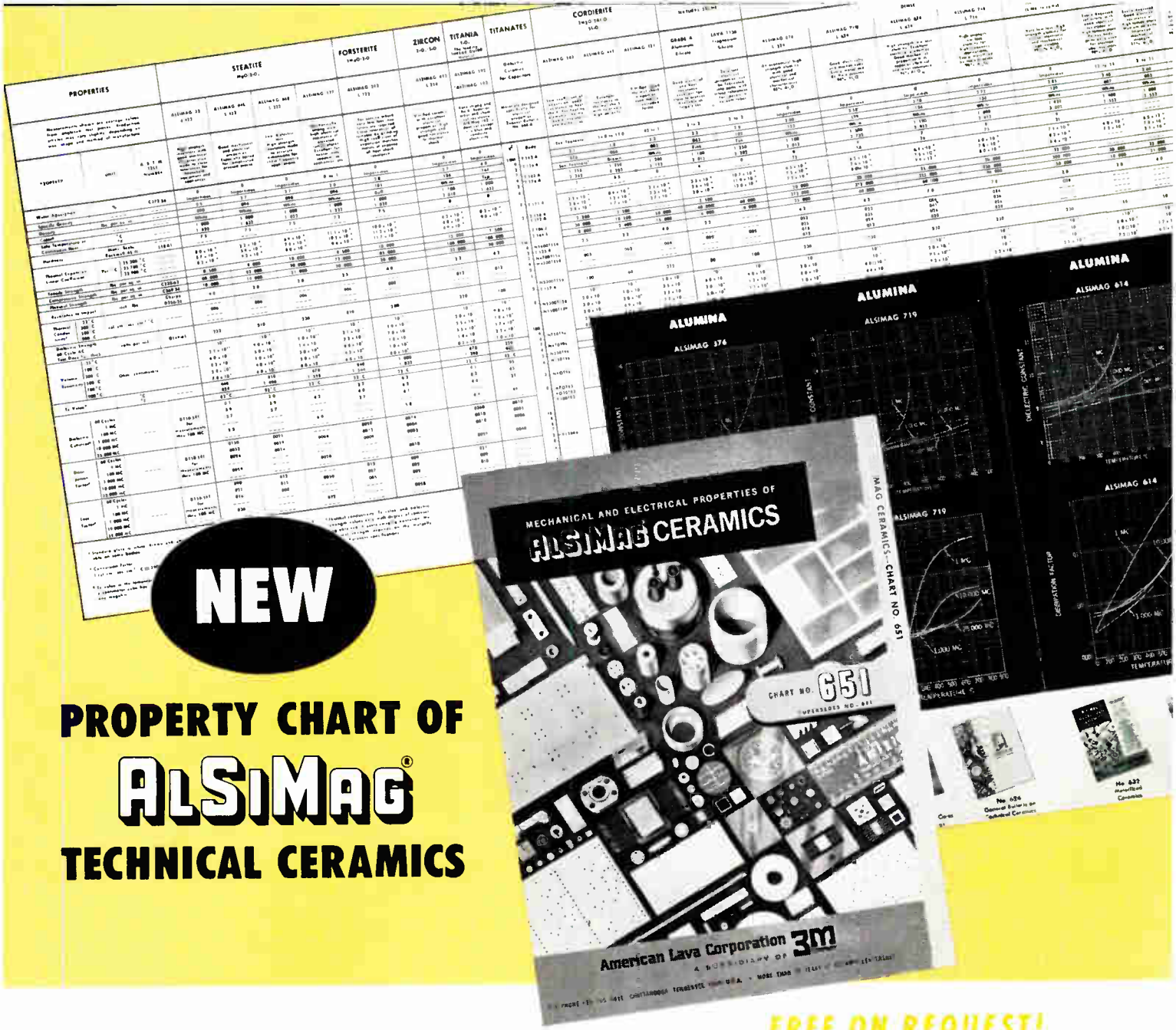

PROPERTY CHART OF ALSIMAG® TECHNICAL CERAMICS

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This chart gives data which is valuable to any design engineer . . . in electronic, electrical, chemical and mechanical fields. American Lava Corporation offers you the widest choice in technical ceramic materials and processes available from any single source. American Lava has been a custom manufacturer of technical ceramics for more than 60 years and has always stressed engineering, research and close control of quality.

AlSiMag ceramics are unexcelled in electronic and electrical applications because of their superior dielectric properties, especially at high frequencies and elevated temperatures. They are suited to many mechanical and chemical applications. In addition to the many ceramic compositions shown in this new Property Chart, there are a number of other compositions of a more specialized nature that are suggested on an individual basis when the more commonly used compositions do not match the specific requirements of a critical application.

The new Property Chart No. 651 contains factual and comprehensive mechanical and electrical characteristics of the most frequently used AlSiMag ceramic compositions. If your work includes design, production or purchasing of precision technical ceramics, you will find this chart a valuable working tool.

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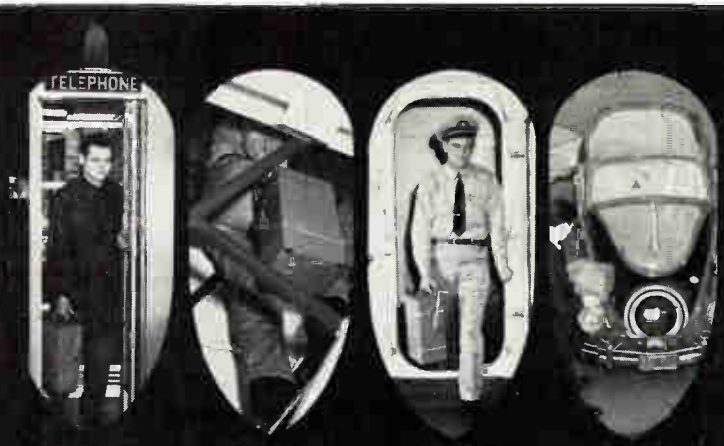
TEKTRONIX®

type 422 portability



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

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No fan needed, yet it runs cool and stays clean.

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Sharp, Bright Displays—even under high ambient light conditions, on rectangular 4" CRT, which provides 7.9 square inches of usable graticule area. (For comparison, 6 cm x 10 cm = 9.3 square inches.)

Quality — same ±3% calibration accuracy, value engineering, careful manufacture, strict quality control, and international engineering support as other Tektronix laboratory oscilloscopes.

Type 422 Oscilloscope (AC only) $1325

Type 422 Oscilloscope (AC-DC) $1750

(Includes set of 20 NiCd cells)

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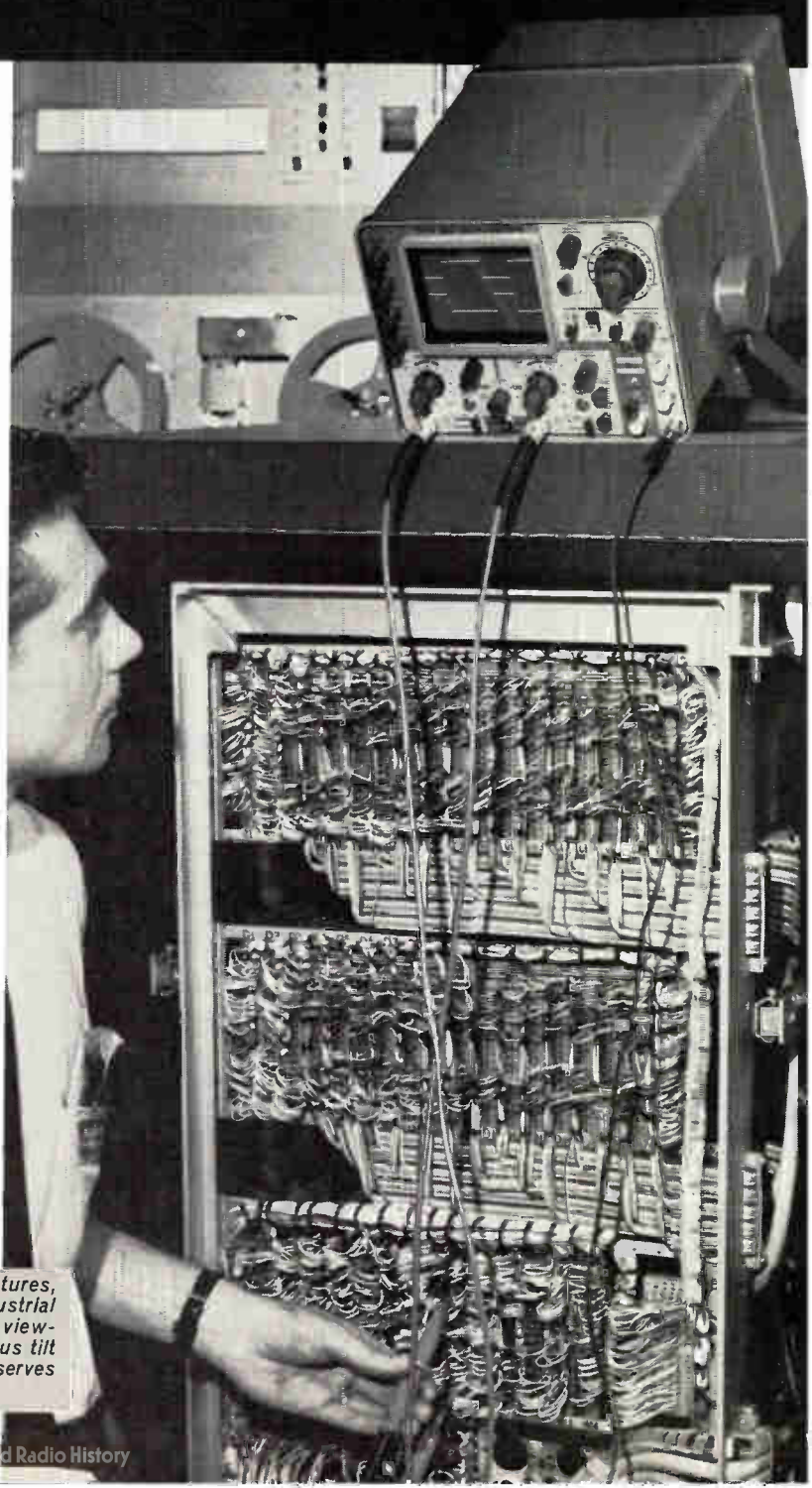
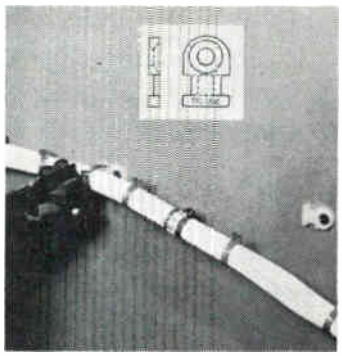
Type 422

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



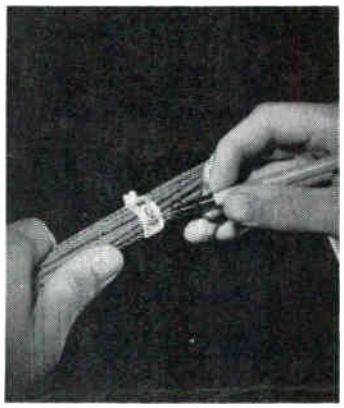
Circle 38 on Inquiry Card

PRE-MOUNTABLE MINIATURE CLAMP PRACTICALLY HIDDEN FROM VIEW



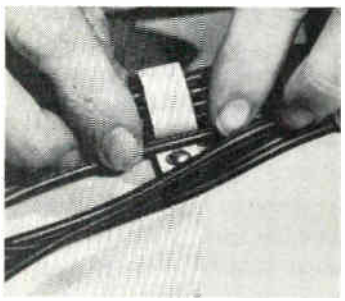
High density electronic packaging and appearance problems are solved with the TY-RAP miniature mount. Harnesses and cables can be tied to these pre-mountable bases with standard TY-RAP ties. The mounts are available in various sizes and accommodate different cable bundle diameters, holding strength up to 50 lbs. Available with screw holes, the mount is easily fastened to chassis. Clamping Section of T&B catalog T66 illustrates over 30 catalog numbers with complete details.

NEW STRAPS IDENTIFY AND TIE



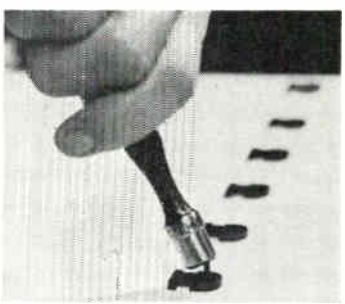
Harnesses, breakouts, cabling, tubes and lab set-ups are easily and quickly tied and identified with TY-RAP Identification Straps. The identification surface is easily marked with pencil, ball point pen, marking pens or heat stamped. Identified wire bundles and harnesses aid trouble-shooting and wire reworking. Since the identifying strap is also a tie, it will not loosen under vibration or stress as can conventional identifying plates. Single and continuous length identification plates are also described in the TY-RAP Identification Section of the 40-page brochure.

NEW SNAP-IN RETAINING CLAMP

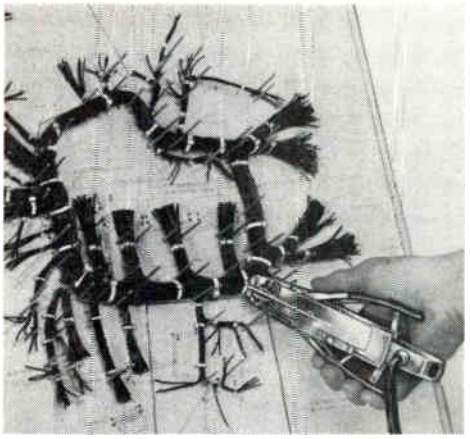


Ideal for supporting long runs of cable in point-to-point wiring. This clamp, TC70 series is available in 5 sizes to accommodate bundles from ¼" to 1½" in diameter. Wire bundles are quickly snapped into place after the clamps have been mounted in position. These clamps are not only recommended for permanent wiring, but also as a handy device for temporary wiring and bread boarding.

NEW KNOCK-IN MINIATURE MOUNT

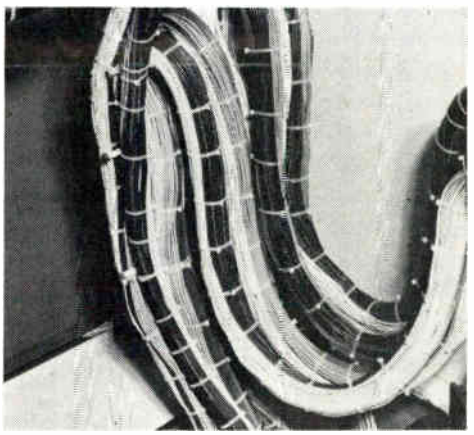


Speed and flexibility are the major benefits of these new knock-in mounting bases. Quick installations are completed simply by knocking in the projecting pin which locks the mount in position. Production flexibility can be achieved by pre-mounting these bases while the harnesses or cable bundles are being fabricated. The clamping section of the new catalog illustrates several types of pre-mountable devices.



TY-RAP™ METHOD SPEEDS INSPECTION

The fact that each tie is isolated and not dependent on other ties, speeds and eases inspection. A glance at the head of the TY-RAP tie will disclose the tying reliability. In the case of harnesses requiring conductor repositioning or circuit changes, only those ties in the re-work section need be removed. When the wiring is corrected, tie or ties can be quickly replaced.



POINT-TO-POINT WIRE BUNDLING SIMPLIFIED

New self-locking TY-RAP ties and manual tools are recommended for field tying and wherever you run wires from one point to another. The photo above is a communications installation which utilizes self-locking ties as well as self-locking clamps and identifying straps.

TY-RAP is a registered trademark of The Thomas & Betts Co. assigned to the line of cable ties, clamps, straps and accessories.

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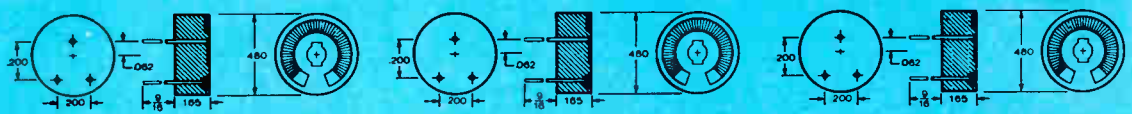

a set-&-forget trimmer

at HALF-the-COST

Clarostat 63 Trimmer

Here's a new hot molded element trimmer with more performance and dependability than you'd ever expect at the price. Electrical specifications of the new Clarostat 63 Trimmer are: .25 watt dissipation rating, at 70°C, working voltage 350 VAC between end terminals. Cost-cutting features include uninsulated construction with contact arm grounded to case. Terminals are located for 1.1 inch grid configuration. Mechanical and electrical rotation are 295°. The Clarostat 63 Trimmer is available in resistance ranges from up to 100 ohms to up to 1 megohm. Write for prices or further information.

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μ-PACS™

3C introduces μ-PACS,™ a broad line of fully integrated monolithic 5mc circuit modules, supplemented by discrete component modules and some integrated/discrete hybrid modules.

With 20 months of in-house funded research and design, 3C has developed standard integrated logic packages with the flexibility of 3C's long-established discrete package lines. This has been achieved while retaining advantages inherent in the integrated circuit — price, size and reliability.

μ-PACS, with a typical noise rejection margin of 1.35 volts, are integrated circuits mounted on etched glass-impregnated epoxy cards. They permit easy design and design modification and simplified procedures for check-out and maintenance.

μ-PACS, with all important circuit inputs and outputs available at connector pins, make possible traditional systems design. Design changes or system expansion are achieved simply by changing or adding modules or wires. Any 3C module can be replaced easily from a small inventory of spares.

μ-PAC circuits, operating from DC to 5 mc, utilize the NAND function, a method initially employed in 3C's S-PACS which became an industry standard, for positive logic. μ-PACS can also be used to directly implement the NOR function for negative logic, or AND-OR logic. 3C chose the NAND operation for positive logic for its μ-PAC family of digital modules because of the simplicity and usage symmetry made possible by the basic NAND gate circuits. All μ-PACS use static logic.

The etched printed circuits have gold-plated fingers for mating to the 34-pin polarized connector. PAC type is clearly indicated on a molded nylon handle by model number and color code.

Auxiliary equipment includes BLOCS for accepting wire wrap or taper pin connectors, power supplies, cooling units, module extractors, extender PACS, manuals, and logic sticker kits.

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- ☐ Have used discrete modules
- ☐ Am contemplating use of integrated circuit modules
- ☐ Have module requirement now
- ☐ Have future module requirement — 6 months ☐ 12 months ☐ 18 months ☐
- ☐ Keeping up with the field

My requirements involve:

- ☐ Specifically integrated circuitry
- ☐ High reliability
- ☐ Frequencies to____megacycles
- ☐ High environments
- ☐ High packing density
- ☐ Ease of system modification/repair
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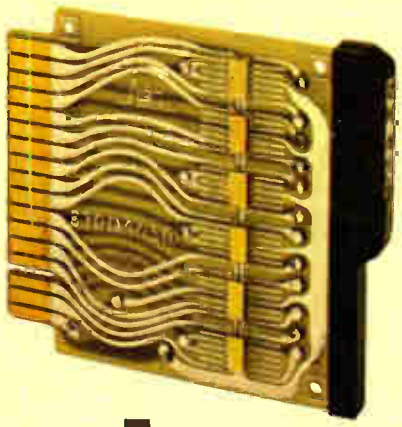

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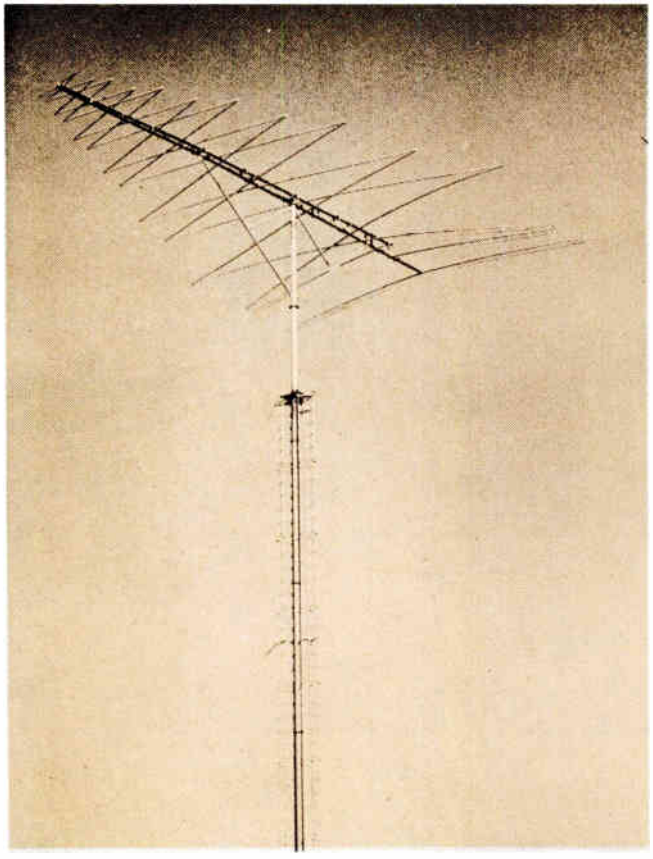

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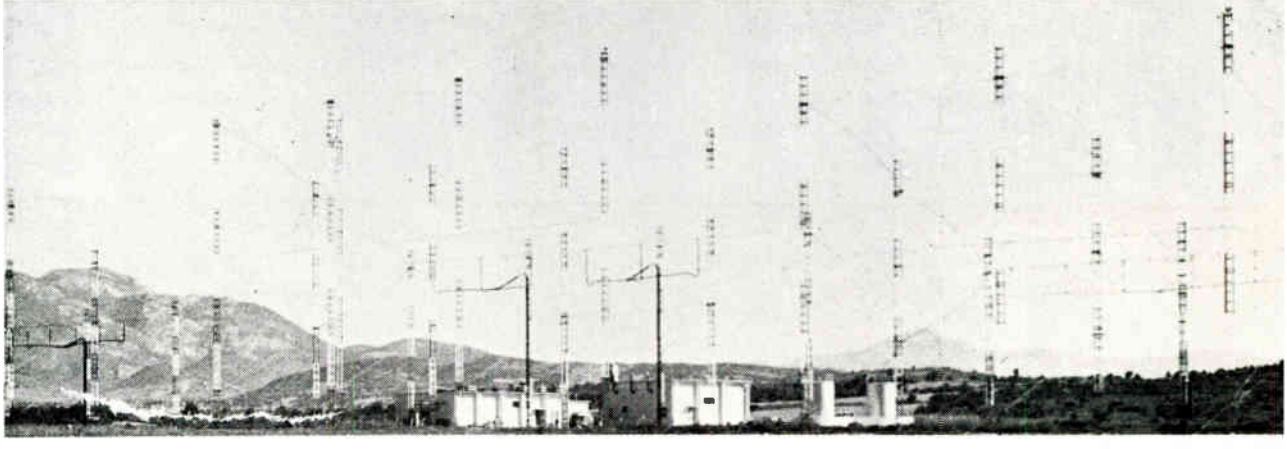
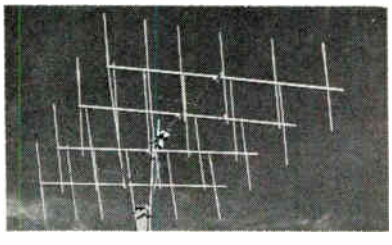
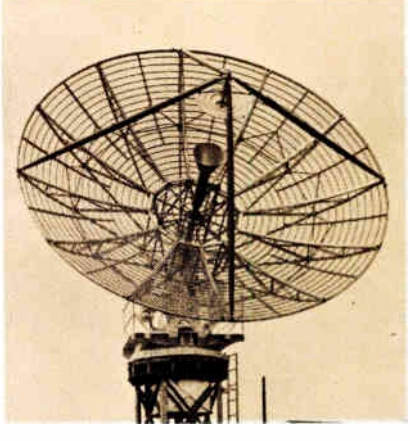
FEATURE

Engineers' Guide to Antenna Selection







Considerations in Selecting Antennas

Linear Antennas

Long-Wire Antennas

Aperture Antennas

New Developments in Luneberg Lenses

Log-Periodic Antennas

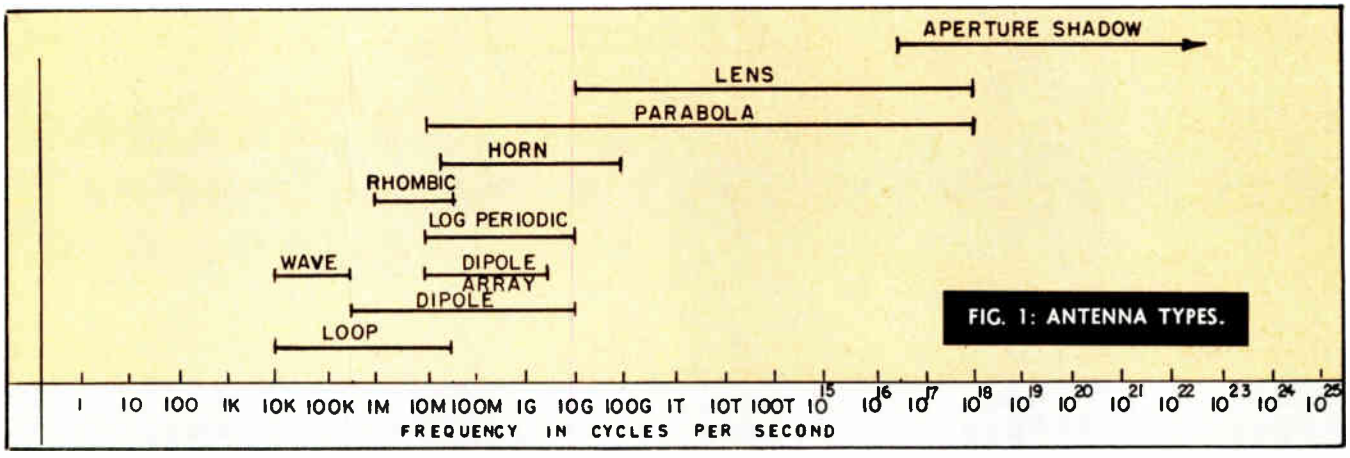


FIG. 1: ANTENNA TYPES.

Considerations In Selecting Antennas

There are several key factors to be considered in selecting an antenna: its purpose, its characteristic, its design, and the service for which it will be used. This article reviews the influence of each. Individual antennas are discussed in the articles that follow this.

Guide to ANTENNA SELECTION—1

THE PURPOSE OF THIS SERIES of articles is to give engineers guide lines for the selection of antennas for specific applications. This part discusses the purpose of an antenna, its characteristics, its design, the missions or services for which it will be used, and finally, how one selects the proper antenna. The other articles of this series by C. T. Tai[1], E. A. Laport[2], R. Mittra & J. D. Dyson[3], and J. W. Eberle[4] give the detailed characteristics of various common antenna types.

The Purpose of Antennas

"An antenna is a means for radiating or receiving radio waves" (ASA 65.36.003)[5]. Stated differently it is a transducer designed to transfer electromagnetic energy from a transmission line to free space. It acts very much like a transformer, it matches the impedance of the transmission line to free space. Also, it may direct the radiated energy in a preferred direction. This latter property is called Directivity (ASA 65.36.231)[5]. A statement of antenna gain or directivity of an antenna in db is a measure of the ability of the antenna to direct energy in a specified direction. The antenna is not an amplifier.

Characteristics of Antennas

The characteristics of an antenna which specify its performance are: Terminal impedance, bandwidth, power gain, polarization and pattern. Definitions of these terms are given here for convenience:

Impedance: The ratio of complex voltage to complex current at the antenna terminals if a TEM transmission system is used. If other systems are used (dominant or multimode waveguide), the impedance is obtained from standing wave measurements for dominant mode systems and very complicated procedures must be used for multimode systems[6].

Bandwidth (B): The steady state bandwidth of an antenna is the difference between the limiting frequencies within which the gain is within 3db of maximum gain. The transient bandwidth of an antenna may be smaller that the steady state bandwidth (dispersive structures such as log-periodic antennas[3]).

Power Gain (g): The power gain of an antenna in a given direction is 4π times the ratio of the radiation intensity in that direction, to the total power delivered to the antenna. This applies to transmitting and receiving antennas (ASA 65.36.237)[5].

Radiation Intensity: The radiation intensity in a given direction is the power radiated from an antenna per unit solid angle in that direction (ASA 65.36.213)[5].

Directive Gain (d): The directive gain of an antenna in a given direction is 4π times the ratio of the radiation intensity in that direction, to the total power radiated by the antenna (ASA 65.36.234)[5]. That is: $g = \eta d$; power gain, — numeric; where d = directive gain — numeric; η = radiation efficiency, — numeric.

By DR. O. M. SALATI,
Assoc. Professor,
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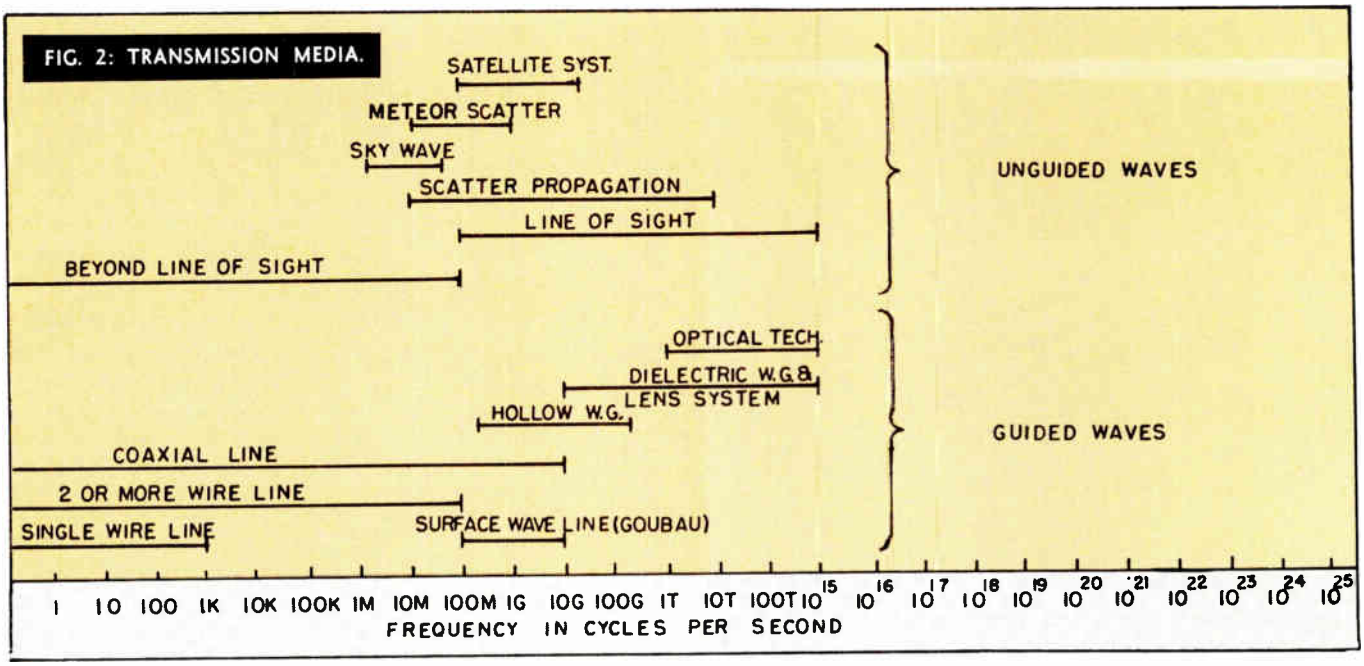

Radiation Efficiency (η): The radiation efficiency of an antenna is the ratio of the power radiated to the total power supplied to the antenna at a given frequency (ASA 65.30.216)[5].

Polarization: The polarization of an antenna depends on its design. The polarization may be elliptical (the most general state), circular right handed (clockwise), or circular left handed (counterclockwise), and vertically or horizontally plane polarized. The plane of polarization of a plane polarized wave is the plane containing the electric field vector and the direction of propagation.

The handedness of an elliptically polarized wave (circular special case) is given by the direction in which the electric field vector rotates for an observer looking in the direction of propagation of the wave.

Pattern: The antenna directivity diagram or pattern is a curve representing, in polar or cartesian coordinates, a quantity proportional to the gain of an antenna in the various directions in a particular plane or cone. In lieu of patterns, qualitative descriptions such as gains for main, side, and back lobes or front-to-back ratio are used.

The pattern of an antenna is a function of the region of the antenna. It is convenient to distinguish between small radiators (size of the order of one wavelength or less) and large radiators (size much larger than one wavelength).

Small Radiators: The regions of small radiators contain three types of terms, that is: electrostatic field terms (field decreases as $1/r^3$ where r = distance from radiator); induction field terms (field decreases as $1/r^2$) and radiation field or Fraunhofer region terms (field decreases as $1/r$). The electrostatic and induction field terms constitute a non-radiating or standing wave field. These are shown in Fig. 3.

Large Radiators: The regions of large radiators or aperture antennas, Fig. 4, are the near field, the Fresnel region and the Fraunhofer region (far field or radiation field). The term induction field, as defined for small radiators is not meaningful, but important field terms decaying inversely as higher powers of the distance than the first (i.e., $1/r^n$ where $n>1$) are usually called near field terms.

Fraunhofer Region: That portion of the radiation field for which radiation patterns are independent of the distance r from the aperture. The field decreases as $1/r$ and for all practical purposes, one may speak of it as a plane wave field. For current elements, the boundary between the Fraunhofer and induction field regions is given by $r>4\lambda$ (induction field amplitude $< 10\%$ of radiation field). For large aperture antennas, the boundary between the Fresnel region and the Fraunhofer region is usually given by $r > \frac{2l^2}{\lambda}$ (there is less than 10% error in the assumption that the field is a plane wave).

Fresnel Region: That portion of the radiation field for large aperture antennas, lying between a distance $r > \lambda$ and $r < \frac{2l^2}{\lambda}$ from the aperture where l is the largest linear dimension of the aperture. Antenna patterns are not independent of distance from the aperture in the Fresnel region, and most of the radiated energy is contained within a cylinder swept out by the aperture of the antenna for $\lambda < r < \frac{2l^2}{\lambda}$.

Design of Antennas

The design of an antenna is a function of the mission or service for which it is desired. Usually, the antenna is intended for a specific band of frequencies, that is, the design band. In the design band, the above mentioned characteristics are specified and controlled.

Outside of the design band, specification and control

of antenna characteristics is very unusual and *unnecessary if the associated transmitters and receivers are perfect.* Since most transmitters have spurious outputs and receivers have spurious responses, information on out-of-band performance is essential.

If the antenna aperture amplitude and phase distributions are known, its performance can be calculated. The mathematics needed for solving this problem are formidable, even for simple distributions in the design band. The aperture distribution, outside of the design band, depends critically on higher order modes of transmission in transmission lines and along the structure of the antenna, as well as on irregularities and tolerances of the antenna surface, feed supports, etc. The higher order modes are not usually controlled since they normally do not affect in-band performance. For these reasons few problems of out-of-band antenna performance have been solved theoretically (some solutions for the linear dipole and the exponential horn are available).

Data for out-of-band performance have been obtained experimentally in laboratories.. [7, 8, 9] The conclusions of these reports are:

a. Dipoles and Disc-Cones: The insertion gain (including the effects of terminal mismatch) in db in the direction of maximum gain increases, essentially, linearly with frequency over a 20:1 frequency range. In a direction perpendicular to the antenna axis, the usual use direction, the gain remains essentially constant.

b. Exponential Horn: The insertion gain in db in the direction of the antenna axis is essentially constant over an 8:1 frequency range. The lobe structure is critically dependent on feed system, as well as excitation system. There is poor polarization discrimination outside of the design band.

c. Parabolas: The insertion gain in db, front to back ratios and side lobe levels tend to remain constant over a 10:1 frequency range.

Antennas have been designed in many forms. A few of these are:

Fan-beam, cosecant-squared, musa, loop, dipole, whip, doublet, capacitor, biconical, pillbox, cheese, corner-reflector, fishbone, turnstile, helical, coaxial, folded-dipole, sleeve-dipole, sleeve stub, slot, J, V, top loaded, Adcock, long-wire, wave or Beverage, rhombic, horn, dielectric, parabolic, lens, log-periodic, and many arrays made up of elements of the previously mentioned types[5].

The above types can be treated in four major categories, that is: linear antennas[1], long-wire antennas[2], log-periodic antennas[3], and aperture antennas[4] as shown in the other articles of this series. The frequency region over which these antenna types are useful is shown in Fig. 1 [10].

Mission or Services

The missions or services for which an antenna will be used must be given. Fortunately, most of these fall in the following services: Broadcasting, amateur, mobile, fixed (point-to-point), radio navigation and radio location or determination. Brief descriptions[11] and antenna requirements will now be given.

Broadcasting Service: A radio communication service in which the transmission are intended for direct reception by the general public. This service may include sound transmissions, TV, weather, time signals and other types of transmissions.

If the transmitter is located in the center of the service area, its horizontal radiation pattern may be omnidirectional. Because the broadcasting service is usually interference limited and many transmitters must share the same channel, it is often necessary to adjust the horizontal radiation pattern to reduce or avoid transmissions in the direction of the interfered station. Frequently (especially for the TV service), the antenna is located on a high spot which is not in the center of the service area. In this case, antennas used must have directional horizontal radiation patterns. It is normal, especially at the higher frequencies, to use directive vertical radiation patterns. Vertical polarization is used in the broadcast band and horizontal polarization in the FM and TV bands.

Receiving antennas, especially at the lower frequencies, have omnidirectional radiation patterns. This is desirable in radio broadcasting since all of the trans-

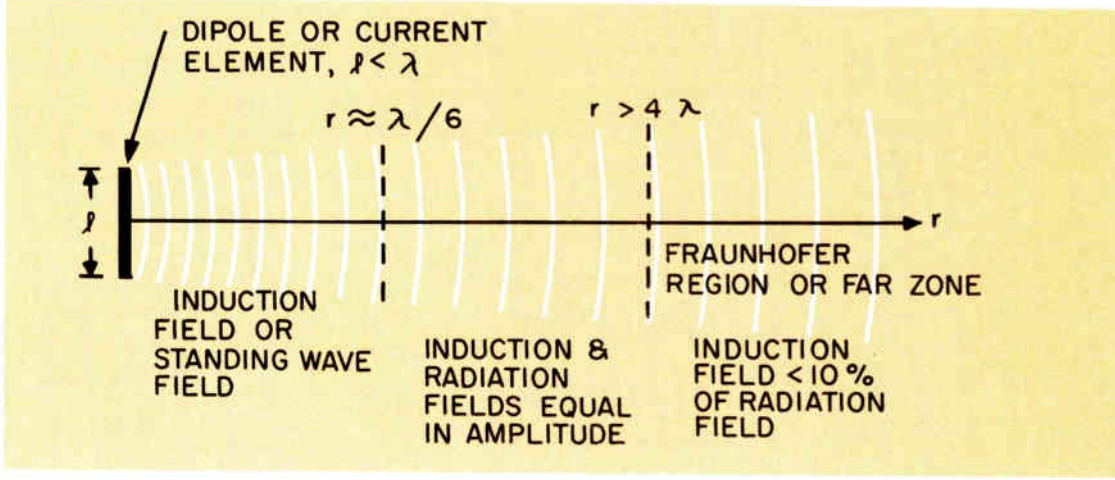

Fig. 3: Fields from a small dipole or current element.

mitters the receiver may be interested in are not generally in the same direction. The opposite is usually true in TV broadcasting. For reasons of tower economy, among others, most transmitting antennas occupy the same or adjacent towers. In this case, it would be desirable to use directive receiving antennas to maximize the desired received signal and to discriminate against signals and reflections from objects which may cause ghosts.

Amateur Service: A service of self-training, intercommunication and technical investigations carried on by amateurs, that is, by authorized persons in radio technique solely with a personal aim and without pecuniary interest.

Both omni- and directional antennas are used. Polarization may be vertical or horizontal.

Mobile Service: A service of radio communication between mobile and fixed stations or between mobile stations. This includes land and sea vehicles and aircraft. It may include non-stationary space satellites.

The fixed station antenna requirements are about the same as for the broadcast service. The mobile station antennas are usually omnidirectional. For non-stationary satellites, directive fixed station antennas are usually required. Vertically polarized antennas are most used.

Fixed Service: A service of radio communication between specified fixed points. This service may include stationary orbit space satellites.

The antennas at both ends of the communications link are usually directive in both vertical and horizontal patterns. The polarization may be vertical, horizontal or circular.

Radio Navigation, Location & Determination Service: These services use radio communications for the purpose of navigation, location or determination. The antennas used are usually directive. They may have pencil beams (height finders or trackers) and fan-shaped or cosecant-squared beams (search radars or direction finders). In some cases, the antennas are omnidirectional or retrodirective types (corner reflectors, etc). The antenna requirements depend on the specific system used. The polarization may be vertical, horizontal or circular.

Selection of Antennas

The services for which the antenna is intended establish certain of the antenna parameters, for instance, the frequency band, polarization and type of antenna pattern. The allowable frequency bands for the various services are given in references 11, 12 and 13.

The operating frequency band also helps to establish the types of transmission lines which may be used with the antennas, and the types of propagation media which may be involved (Fig. 2 from Ref. 10). Here several choices may be available. For instance, between 50 and 100 MC, both two-wire lines and coaxial lines are used. The choice will depend on allowable transmission line losses, the necessity for a completely shielded line, and cost.

With the transmission line, antenna pattern, and polarization specified, one may now select the type of antenna to use and some of its remaining characteristics. An example will show the procedure.

Let us assume it is the TV broadcast service and that a receiving antenna is needed. Cost and low transmission loss dictates the use of two-wire line having a characteristic impedance of 300 ohms. The service is horizontally polarized. The receiver is in a weak field from the station, and since all stations of interest are in the same general direction, a undirectional antenna is required. This antenna may now be a Yagi array of horizontal dipoles, a rhombic or a log-periodic unit. If the tuning range of the receiver is large, say 5 or 10 to 1, adequate coverage can be secured by a single log-periodic or several Yagi arrays. The final choice will depend on cost, as well as the required gain to get adequate signal strength. If the transmission line between the receiver and antenna is long (more than a few wavelengths) then the antenna to transmission line impedance must be very well matched to avoid reflections or ghosts in the received picture.

If in the above example the reception of stations in different directions was required, one could use a directive antenna with a rotator, separate directive antennas for each station, or a single antenna with a directional pattern suitably distorted to encompass both stations. The latter solution may be expensive if other

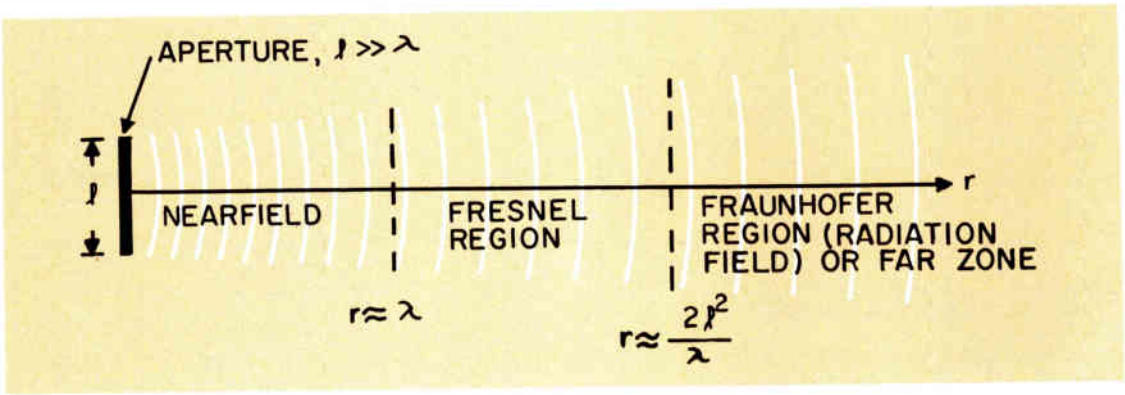

Fig. 4: Fields from a large aperture antenna.

ANTENNA SELECTION (Concluded)

than bi-directional response (opposite directions) is required.

The above procedure would be used for other examples. Gain requirements can be determined from minimum field strengths required for the service[13] or from the transmission formula. For free space propagation, with no multipath phenomena, the transmission formula is:

$$P_R = \frac{P_T\, g_T\, g_R\, \lambda^2}{16\pi^2\, r^2}$$

Where: P_R = received power in watts;
g_R = receiver antenna gain, numeric;
g_T = transmitter antenna gain, numeric;
r = separation distance between receiver and transmitter in meters;
and λ = wavelength in meters.

In the use of the above transmission formula or in other transmission formulas, the antenna power gains used are the far field gains if the separation distance r assures far field conditions. If operation must be in the Fresnel region, then Fresnel region correction factors must be applied to the antenna gains[14].

If the considerations in the choice of antennas are high directivity and freedom from noise and interference, then antenna designs having low side lobes and high front-to-back ratios must be used. These may be large apertures such as horns, lenses, parabolas, or arrays. Most of these are capable of giving the required performance and cost must therefore be a design factor.

For low noise antennas such as used in satellite communications or radio astronomy, the design consideration should be high signal to noise ratio rather than high front-to-back ratio[15].

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COAXIAL CONNECTOR FOR PRINTED CIRCUIT

CONNECTING A COAXIAL CABLE to a printed-circuit board where the cable terminates has been a problem. Coaxial connectors generally used are bulky and heavy, so that the connection to a printed-circuit board may be of doubtful reliability.

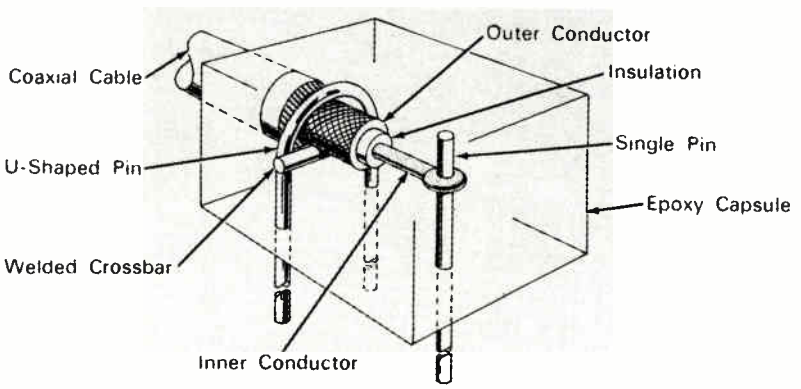
A compact coaxial connection that uses soldering and welding techniques and eliminates standard coaxial connectors for permanent connection is a solution.

In place of a coaxial connector normally used, a U-shaped pin having a welded crossbar is used. The outside insulation of the cable is stripped back and the shielding is soldered to the U-pin, thus providing the ground contact.

A connection is made to the inner conductor by soldering to a single pin. After connections have been made, the entire device is enclosed in a rigid epoxy resin block that provides structural strength and protects the connections from damage.

This method eliminates coaxial connectors and is most useful where the coaxial cable is to be permanently connected to a printed-circuit board. Applications could include aerospace equipment and aviation electronic devices where high reliability and low weight are important.

For further information contact: Technology Utilization Officer, Manned Spacecraft Center, P. O. Box 1537, Houston, Tex. Ref. B64-10016



LINEAR ANTENNAS

The category of linear antennas includes: dipole arrays, cylindrical dipoles, biconical dipoles, discones, folded dipoles, sleeve dipoles, monopoles, and loops. To better understand these antennas, essential formulas involved in antenna theory are given, along with important characteristics.

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THE CHARACTERISTICS OF AN ANTENNA when used for transmitting and receiving, are often described by different parameters, although they are closely related. In the case of a transmitting antenna, the two most important parameters are the directivity and the input impedance. When the same antenna is used for receiving, we are interested in the maximum power which the antenna can extract from the incoming wave. Hence, a parameter called receiving aperture is used to describe the receiving capability of the antenna. We shall show later that the directivity and the receiving aperture of an antenna are intimately related. Before we outline the important characteristics of linear antennas, it is desirable to review some of the essential formulas involved in the antenna theory.

The far-zone electric field of any transmitting antenna $\overline{E}$ when excited by a harmonically oscillating source can always be written in the form

$$\overline{E} = \frac{-j\omega\mu}{4\pi}\,\frac{e^{-jkR}}{R}\,(N_\theta\,\hat{\theta} + N_\phi\,\hat{\phi}) \qquad (1)$$

where

$\omega = 2\pi f$

$\mu = 4\pi \times 10^{-7}$ henrys/meter

$k = 2\pi/\lambda$

N_θ and N_ϕ are the θ and ϕ components of the current moment vector.

defined by:

$$\overline{N} = \iiint \overline{J}\,(r')\,e^{jkr'\cos\alpha}\,dV' \qquad (2)$$

$\overline{J}\,(r')$ = the current density function describing the distribution on the antenna.

The quantities defined in Eqs. 1 and 2 are shown on Fig. 1.

For the convenience of describing the receiving characteristics of an antenna, it is desirable to introduce a vector effective height function $\overline{h}$ defined as follows:

$$I_i\,\overline{h} = N_\theta\,\hat{\theta} + N_\phi\,\hat{\phi} \qquad (3)$$

Where I_i denotes the input current defined at the antenna terminals. The function $\overline{h}$ has the dimension of length, and its variation with respect to θ and ϕ describes the two pattern functions pertaining to E_θ and E_ϕ.

For linear antennas, the current is confined to a filament of wire, Eq. 2, therefore, can be written

$$\overline{N} = I_i \int \overline{F}\,(r')\,e^{jkr'\cos\alpha}\,dl' \qquad (4)$$

where $\overline{F}\,(r')$ denotes the current distribution function on the filament, normalized with respect to the input current. When the antenna is driven by a voltage V_i at the input terminal, its input impedance is defined by

$$Z_i = V_i/I_i \qquad (5)$$

(Continued on following page)

Fig. 1: Quantities involved in description of far-zone field.

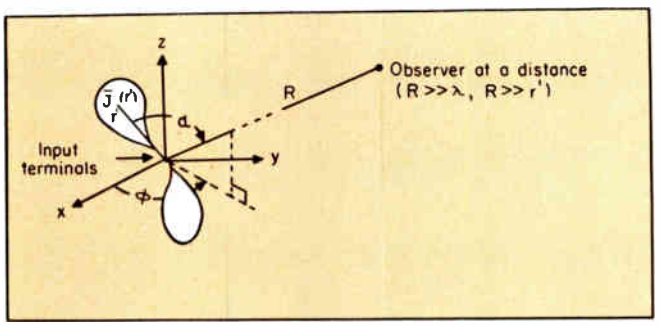
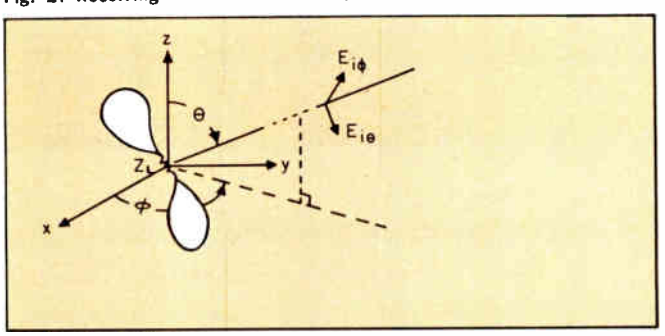


Fig. 2: Receiving ant. in field of elliptically polarized wave.



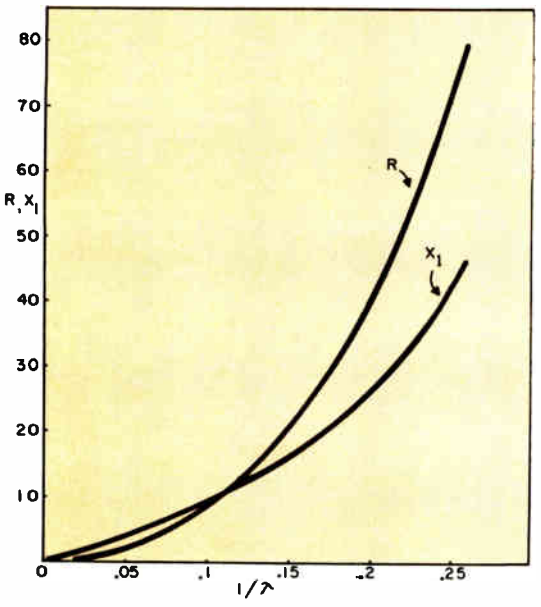


Fig. 3 (left): R and X_1 of a linear antenna.

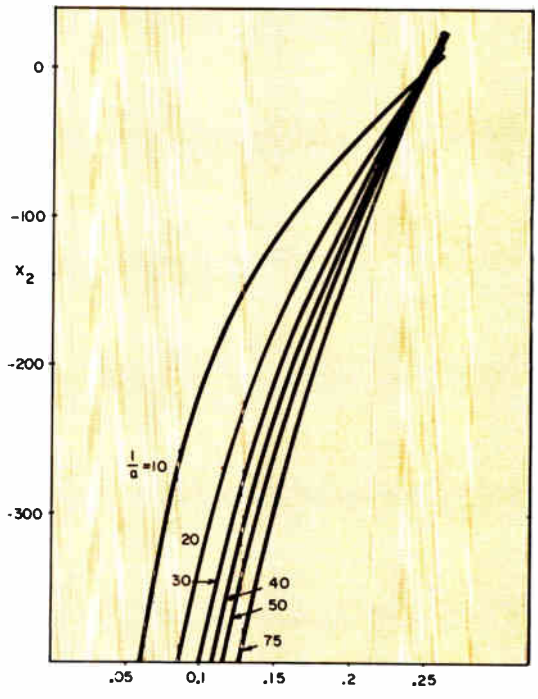


Fig. 4 (right): X_2 of a linear antenna. See text for a description.

LINEAR ANTENNAS (Continued)

The directivity of an antenna is related to its effective height by the following:

$$D = \frac{4\pi\,(\bar{E}\cdot\bar{E}^*)_{max.}}{\int\int (\bar{E}\cdot\bar{E}^*)\,d\Omega} = \frac{4\pi\,(\bar{h}\cdot\bar{h}^*)_{max.}}{\int\int (\bar{h}\cdot\bar{h}^*)\,d\Omega} \qquad (6)$$

As we see now, the current distribution function $\bar{F}(r')$ is the key function in finding the directivity of linear antennas. Fortunately, for a straight thin linear antenna, it is known both from approximate theories and experiment that the current is almost sinusoidally distributed. Much information can thus be obtained from the sinusoidal current distribution. In regard to the input impedance of linear antennas, in spite of the great volume of theoretical contribution of the problem, there is still some uncertainty as to the effect of the exact shape of antenna terminals upon its impedance.

There is strong evidence that for the most commonly used straight linear antenna, i. e., operated under the condition that its over-all length does not exceed $\lambda/2$, its input impedance is given quite accurately by the formula obtained from the induced EMF method.[1]

The above discussion so far applies to an isolated linear antenna. If we have an array of N linear antennas, then, the far-zone field is given by

$$\bar{E} = \frac{-j\omega\mu e^{-jkR}}{4\pi R}\sum_{n=1}^{N} I_n\,(h_{n\theta}\,\hat{\theta} + h_{n\phi}\,\hat{\phi}) \qquad (7)$$

where

I_n = input current to the *nth* element which has an effective height $h_{n\theta}\,\hat{\theta} + h_{n\phi}\,\hat{\phi}$.

Instead of a single impedance function, the input voltage and the input current are related by the self and the mutual impedances through the Carter's relations[2]

TABLE 1

Antenna	Current distribution	Effective height	Directivity
short dipole	$I_z = I_i\left(1 - \frac{\lvert z\rvert}{l}\right),\ \lvert z\rvert \le l$	$h_\theta = -l\sin\theta$	$0.116\,\lambda^2$
half-wave dipole	$I_z = I_i\cos\left(\frac{2\pi}{\lambda}z\right),\ \lvert z\rvert \le \frac{\lambda}{4}$	$h_\theta = -\frac{\lambda}{\pi}\frac{\cos\left(\frac{\pi}{2}\cos\theta\right)}{\sin\theta}$	$0.130\,\lambda^2$
small loop of radius "a"	$I_\phi = I_i,\quad 0 < \phi \le 2\pi$	$h_\phi = j\frac{2\pi^2 a^2}{\lambda}\sin\theta$	$0.116\,\gamma^2$
half-wave folded dipole	each arm with a sinusoidal current	twice of a half-wave dipole	$0.130\,\lambda^2$

$$\begin{Bmatrix} V_1 \\ V_2 \\ \cdot \\ \cdot \\ V_n \end{Bmatrix} = \begin{Bmatrix} Z_{11}\ Z_{12} \cdots Z_{1N} \\ Z_{21} \cdots \\ \cdot \\ \cdot \\ Z_{N1} \cdots Z_{NN} \end{Bmatrix} \begin{Bmatrix} I_1 \\ I_2 \\ \cdot \\ \cdot \\ I_N \end{Bmatrix} \tag{8}$$

When an antenna is used for receiving, in place of the driving voltage, it is terminated by a load impedance Z_L as shown in Fig. 2.

The incident field, in general, may be an elliptical wave which is characterized by two orthogonal components $E_{i\phi}$ and $E_{i\theta}$. The load current is then given by

$$I_L = \frac{\bar{h} \cdot \bar{E}_i}{Z_L + Z_i} \tag{9}$$

where $\bar{h}$ is the effective function defined by Eq. 3, and $\bar{E}_i$ is the incident field measured at the antenna terminals. If we define the impedance matching factor q and polarization matching factor p according to the following formulae[3]

$$q = 1 - \left| \frac{Z_L - Z_i^*}{Z_L + Z_i} \right|^2, \tag{10}$$

*There is a typographical error in a previous writing on this subject (Jasik, Antenna Handbook, p. 3-2, McGraw-Hill Book Co.) The term $\ln(2l/a)$ should read $\ln(l/a)$.

$$p = \frac{1 + 2\,s\,t\cos(\alpha + \beta) + s^2 t^2}{(1 + s^2)(1 + t^2)} \tag{11}$$

where

$$s\,e^{j\alpha} = E_{i\phi}/E_{i\theta}, \quad t\,e^{j\beta} = h_\phi/h_\theta$$

then, the received power is given by

$$P = A\,S_i \tag{12}$$

where

S_i = incident power density

$$= \frac{1}{2\,\eta} |\,E_i\,|^2$$

A = receiving aperture

$$= \frac{D\,\lambda^2}{4\,\pi}\,p\,q$$

The received power is maximum for matched load, q = and matched polarization, $p = 1$. The matched polarization implies that when the incident wave is an elliptically polarized wave with certain sense of rotation, then the antenna when transmitting must produce a similar elliptically polarized field, but with opposite rotation. Receiving antennas consisting of an array of linear antennas have not been investigated thoroughly. Thus, no precise information is known about their optimum receiving aperture with respect to loading.

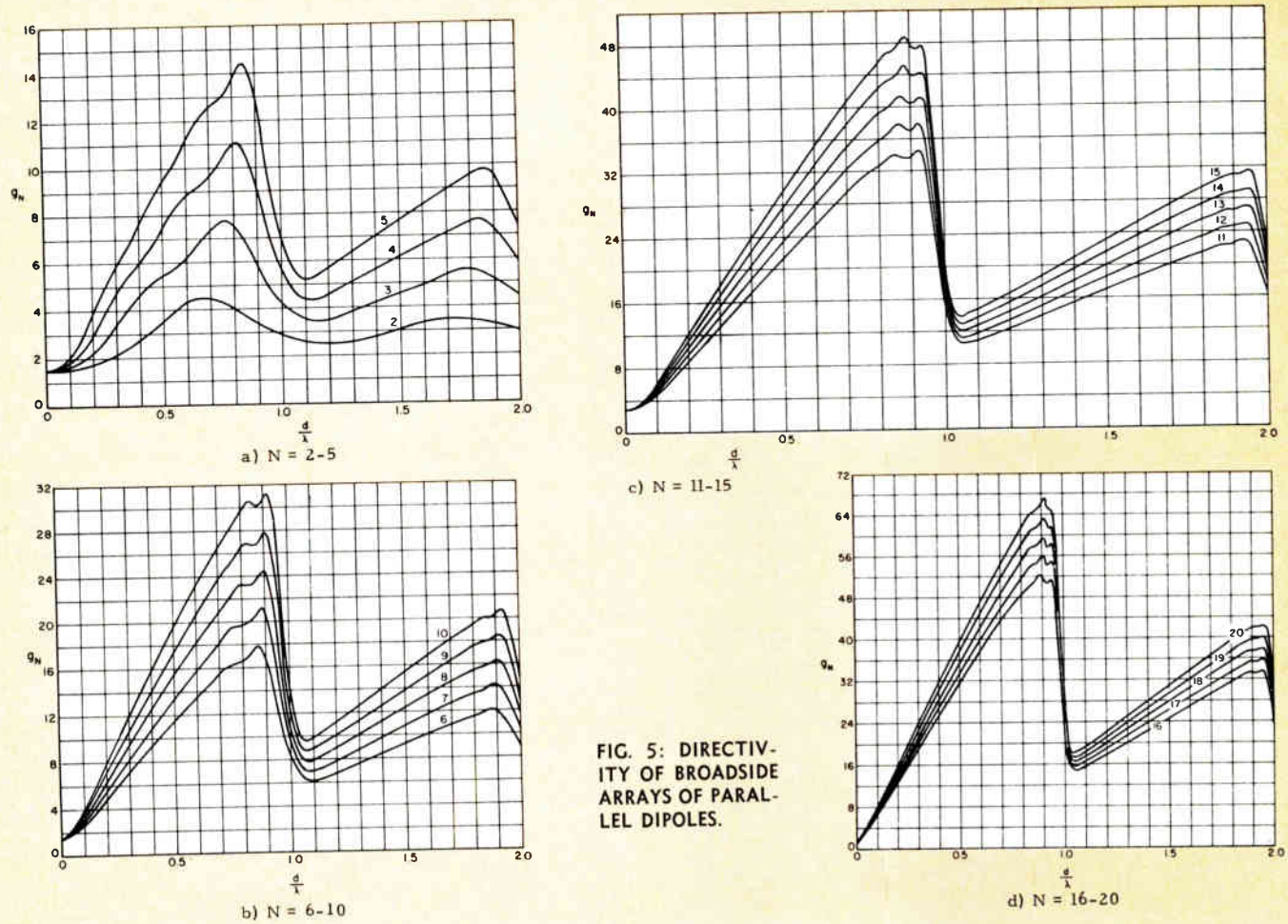


FIG. 5: DIRECTIVITY OF BROADSIDE ARRAYS OF PARALLEL DIPOLES.

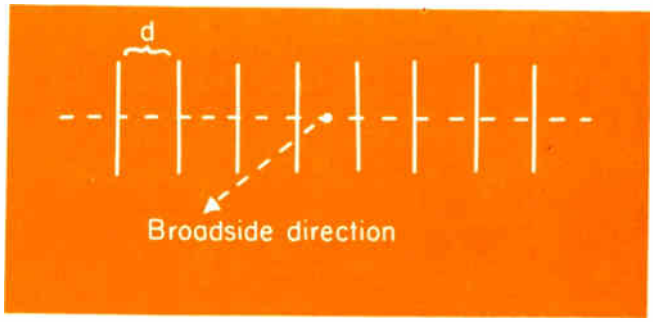


Fig. 6: Broadside array of parallel dipoles is illustrated.

LINEAR ANTENNAS (Concluded)

Directivity & Effective Height

For frequent references, we list in Table 1 the effective height and directivity of some simple linear antennas using the current distribution listed in the second column. These distributions are known to be good approximations in evaluating these quantities.

Z of Center-Fed Linear Antennas

In spite of the large amount of theoretical work, there is not an exact method for evaluating the impedance of an antenna. For center-fed linear antennas, the old induced EMF seems to be good enough to give a reliable estimate. Since straight wire antennas are hardly used nowadays with a length over one-half wavelength, it seems sufficient to give the data for the region slighty over $l = \lambda/4$. The data is shown in Figs. 3 and 4 based upon the expression

$$Z = R + j\,(X_1 + X_2) \tag{13}$$

where X_2 denotes the part which depends upon the radius of the wire, a. X_2 also is principally responsible for the reactance when the antenna is short. The expression for X_2 is given by

$$X_2 = -120\left(ln\,\frac{l}{a} - 1\right)\cot\left(\frac{2\pi l}{\lambda}\right) \tag{14}$$

Sleeve and Conical Dipoles

While the center-fed cylindrical antenna is the simplest type of linear antenna and is the most commonly used, sleeve dipoles and conical dipoles have better impedance characteristics. A conical antenna can be designed so that its characteristic impedance matches that of the transmission-line. Thus, a 90° conical antenna mounted on a ground plane would match, very well, a coaxial line with an impedance of 50 ohms. The characteristic impedance of a biconical dipole is given by

$$Z_c = 120\ ln\cot\frac{\theta_0}{2} \tag{15}$$

Where $2\theta_0$ denotes the apex angle of the cones. For a single cone with a ground plane, the value of Z_c is equal to one-half of the value given by Eq. 15. To reduce the weight of the metallic surface, the latter can be replaced by slanted rods without affecting too much its electrical characteristics.

Arrays of Dipoles

Cylindrical antennas are used often as the elements of an array. Large arrays of this type have been installed in recent years either for radars or for radio-astronomical work. The directivity of uniform arrays of dipoles can be evaluated in closed forms if we assume each element has a figure-eight pattern, corresponding to that of a short dipole. For a single row of broadside array of parallel dipoles as shown in Fig. 6 the directivity is given by[4]

$$D = \frac{3N/2}{1 + \frac{3}{N}\sum_{r=1}^{N-1}(N - r)\,P_r\,(kd)} \tag{16}$$

where

$$P_r\,(kd) = \left[1 - \frac{1}{(rkd)^2}\right]\frac{\sin\,(rkd)}{rkd} + \frac{\cos\,(rkd)}{(rkd)^2}$$

and N denotes the number of elements. Eq. 16 is plotted in Fig. 5 as a function of the spacing. The maximum directivity occurs when d is slightly less than a wavelength. The directivity decreases drastically when another pair of main lobes start to appear in the end-fire directions. By changing the phase of the current which excites each element, it is possible to tilt the main beam in any desirable direction other than the broadside. If a uni-directional beam is desired, one may use a conducting screen as a reflector placed at a distance of between one-quarter to one-half wavelength from the array. For radio-astronomical work, one usually uses the natural ground covered with meshed wire as the reflector.

Conclusion

In this short article, we have briefly introduced the basic characteristics of linear antennas. The monumental book on linear antennas by Professor R. W. P. King[5] contains many fine details about this subject. Linear antennas are not the glamorous topics in current antenna research, but they are still the basic elements used in antenna engineering. They will continuously be used as long as rods and wires are available.

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LONG-WIRE ANTENNAS

Long-wire antennas are probably the oldest form of antenna. Three basic types of long-wire antennas are in use—the Vee, the traveling-wave, and the rhombic. The advantages of each are described here.

MECHANICALLY SIMPLE DIRECTIVE ANTENNAS can be made by taking advantage of the intrinsic directivity of electrically long wires with natural standing-wave and traveling-wave current distributions. Figure 1 compares the free-space field-strength radiation patterns for the case of a 4 wavelength straight wire with the two current distributions. Notice that both have the same zero distributions; also that secondary lobe amplitudes diminish regularly for one, while those for the other are reverse-symmetric about the normal to the wire.

The distant free-space field strength radiation patterns follow these relationships:

Traveling-wave case $$f_E(\theta) = \frac{\sin\theta}{\text{vers}\,\theta}\left(\frac{\pi m}{2}\,\text{vers}\,\theta\right) \quad (1)$$

Standing-wave case $$f_E(\theta) = \frac{\sin^*\left(\frac{\pi m}{2}\cos\theta\right)}{\cos^*\sin\theta} \quad (2)$$

in which $f_E(\theta)$ = relative field strength distribution at constant distance

θ = angle to the wire

m = electrical length in half-wavelengths

π = 180° = one-half wavelength

$\text{vers}\,\theta = 1 - \cos\theta$

* Note: In (2) use sine when m is odd; cosine when m is even.

Further study of this comparison shows that

—zero distributions are symmetrical about θ=90°

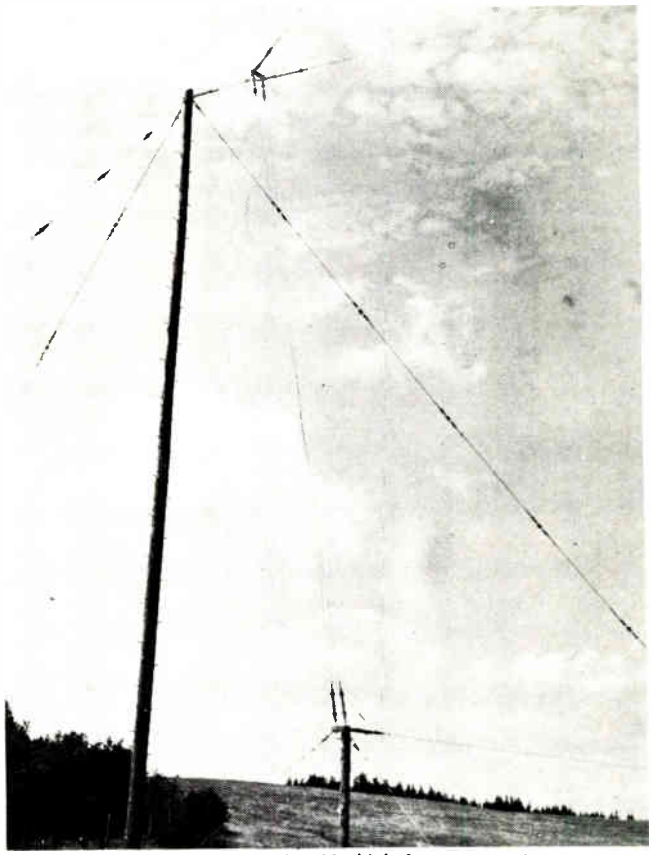
—the angle of the first (main) lobe θ_1 decreases as m increases

—there are m lobes in the pattern, half in each quadrant

—each lobe is a cone of radiated energy around the wire

Vee Antennas

Long-wire antennas are usually formed of two or more wires arranged so that their main lobes reinforce, but all others are reduced by destructive wave interference. At best this can only be partially effective so that all long-wire antenna patterns have several secondary lobes unless designs are elaborated to minimize them.



The input end of a common rhombic high frequency antenna.

The simplest practical long-wire antenna is a vee, fed at its apex. When the apex angle $A=2\theta_1$ the main beam lies in the plane of the vee. For smaller angles there are beams above and below this plane. When the vee is parallel to ground the lower beam is reflected upward. To maximize the main beam its height is that which aligns the reflected and direct beams at a desired elevation angle α, which depends on path length and ionosphere height at the high frequencies.

(Continued on following page)

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LONG-WIRE ANTENNAS (Continued)

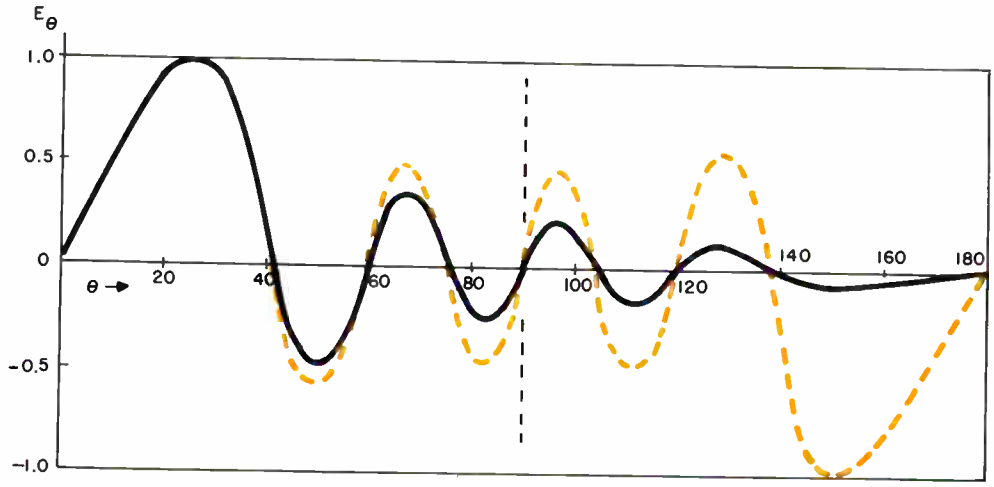


Fig. 1: Free-space normalized field-strength distributions at constant great distance from an ideal 4 λ linear radiator with traveling-wave (—) and standing-wave (+) current distributions, where Θ is angle to wire.

A vee with standing wave current distribution (resonant) has a bidirective pattern. To make this unidirective another vee is needed, similarly excited, to cancel rearward radiation at its operating frequency, and reinforce in the forward direction. Figure 2 shows a unidirective vee type for the 3-30 MC band with reflector and feeds, including a phase adjuster ϕ. The electrical dimensions L, H, S and D and the apex angle A are chosen to align the horizontally-polarized beam at the desired elevation angle. H is that which places the first maximum of the height factor $sin\ (H\ sin\ \theta)$ at that angle.

Traveling-Wave Antennas

To obtain a traveling-wave current distribution all reflection from the distant end must be suppressed. This is done conveniently in the rhombic antenna, which consists of two reversed vees with their outer ends connected. Then the distant ends are connected to a resistor or dissipation line that matches the antenna impedance. Circuitally it acts as a matched transmission line. Equal, but inverted currents flow in the two sides, each having two "legs" whose separate radiation patterns align at a forward elevation angle at a particular frequency. Thus, four legs and four images have direct and reflected patterns aligned along the main beam. Several secondary lobes occur at various angles but judicious design minimizes these, at least at one frequency.

The horizontal rhombic antenna is non-resonant, and from a circuital standpoint appears to the transmitter as a matched transmission line. However, because of its fixed size, its pattern must change with frequency so there are limits to its useful bandwith, beyond which its performance deteriorates extremely. Table 1 includes data on maximum frequency ratios.

Figure 3 shows the basic form of the horizontal rhombic antenna using three wires per side, which is the popular 600 ohm kind for transmitting and receiving. A1-wire rhombic has a characteristic impedance of about 850 ohms, but it varies widely with frequency. The intermediate 2-wire type is often used also.

The L, A, H parameters for the rhombics are closely interrelated with frequency and of course call for careful compromise when the antenna must be wide band.

Table 1 gives some optimum design values for h-f applications, for gain and sidelobe reductions. These are preferred parameters for paths requiring those beam angles.

Rhombic antennas for VHF and UHF applications for very low angle response use apex angles $2\theta_1$ and heights of several wavelengths. *(Continued on page 81)*

Fig. 2: A 2-layer double-vee H-F antenna (electrical portion).

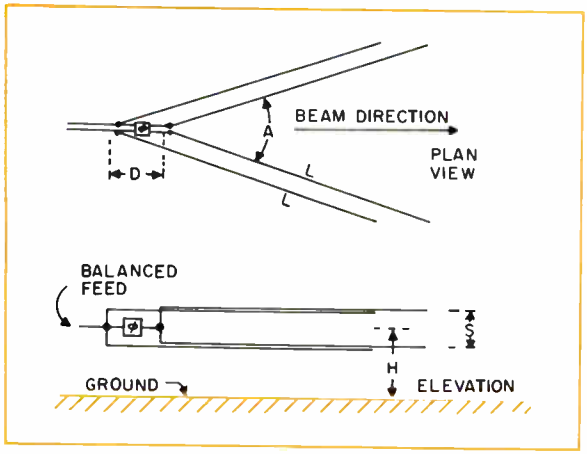
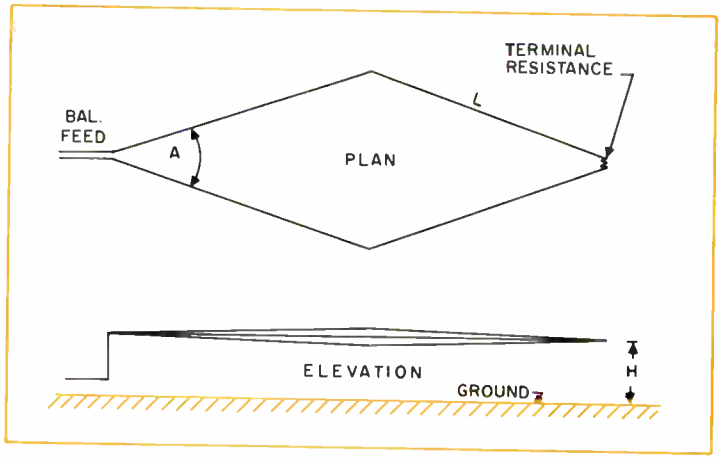


Fig. 3: Basic single-unit horizontal rhombic antenna.



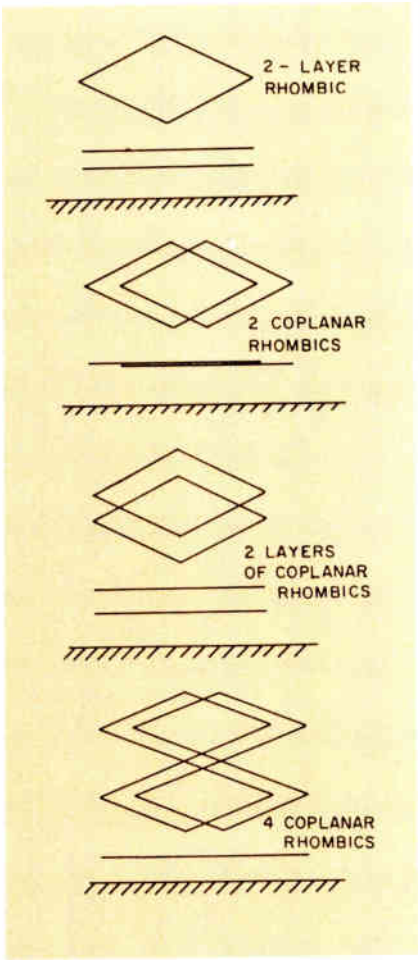


Fig. 4 (left): Plan and elevation views of methods for arraying rhombic units for sidelobe reduction and gain improvement.

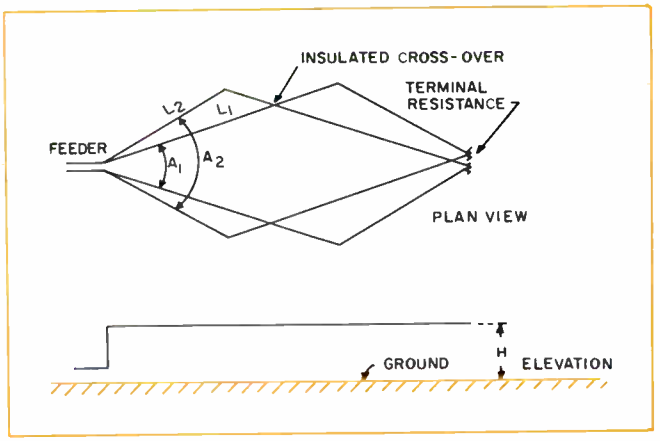


Fig. 5 (right): Basic configuration of single-wire double-rhomboid antenna for gain increase and sidelobe reduction.

Table 1

OPTIMUM HORIZONTAL RHOMBIC ANTENNAS

L/λ	H/λ	A (deg.)	α (deg.)	f_h/f_l max.	B. W. (deg.)	Gain db
2	0.86	62	17	1.2/0.8	53	12
3	1.04	51	14		43	
4	1.16	42	12		36	16
5	1.30	37	11	1.3/0.6	32	
6	1.43	34	10		29	18
7	1.54	31	9.5		27	
8	1.64	29	9	1.4/0.4	25	19

Note: Max. useful frequency range is in terms of ratios of highest and lowest relative to the design frequency. Beamwidth is total between first zeros azimuthally. Gain is relative to half-wave dipole at same height.

Rhombic Arrays

Rhombic units can be arrayed in various ways to increase gain and reduce sidelobes. Figure 4 indicates proven arrays at the expense of more supports and feeder circuit complications. Figure 5 shows an array plan that does both in a simpler manner, with a single feeder and only two more supports. Radiation control is effected by choice of the values of L_1, L_2, A_1, and A_2, and its pattern is the product of L_1, A_1, and L_2, A_2, vee patterns, multiplied again by the height factor $sin\ (H\ sin\ \alpha)$. This double-rhomboid antenna has an input impedance about half that of a single rhombic unit with the same number of wires per size. There is some economy of land with this form.

Note: The principles here are idealized. In real life the radiation and heat losses in a wire cause the zeros to be non-zeros and lobe amplitudes to depart somewhat from their mathematical values. These deviations do not affect practical designing for ordinary engineering applications.

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NON-ELECTROMAGNETIC ANTENNA GUY LINES

THE GUY LINE PROBLEM ASSOCIATED WITH HIGH-FREQUENCY ANTENNAS is greatly reduced by replacing the conventional steel cable guys with a cable made of Mylar®.

The traditional method of guying requires steel cable broken every 10 to 20 feet by porcelain compression insulators. The intervals between the insulators must be non-resonant or they will affect the radiation pattern. These insulators also introduce leakage paths when they are coated with heavy dust, salt spray, and ice.

Synthetic fiber cables eliminate these problems, but their use has been limited because they stretch too much. This problem has been eliminated by U.S. Plastic Rope Inc., 711 Hamilton Ave., Menlo Park, Calif. Mylar film stretches considerably when in tape form, but as it is pulled towards the breaking point the tensile strength increases. At U.S. Plastic Rope the raw material is prestretched, heated, and fused into a fine thread. This thread is woven into antenna guy lines. The finished product, when properly jacketed, is impervious to the elements, has very high breaking strengths, is very light, and needs no insulators.

APERTURE ANTENNAS

Aperture antennas are loosely broken down to reflector antennas, horns, lenses, surface and leaky wave antennas. Of this group, the reflector antenna can be considered the work horse of the antenna industry.

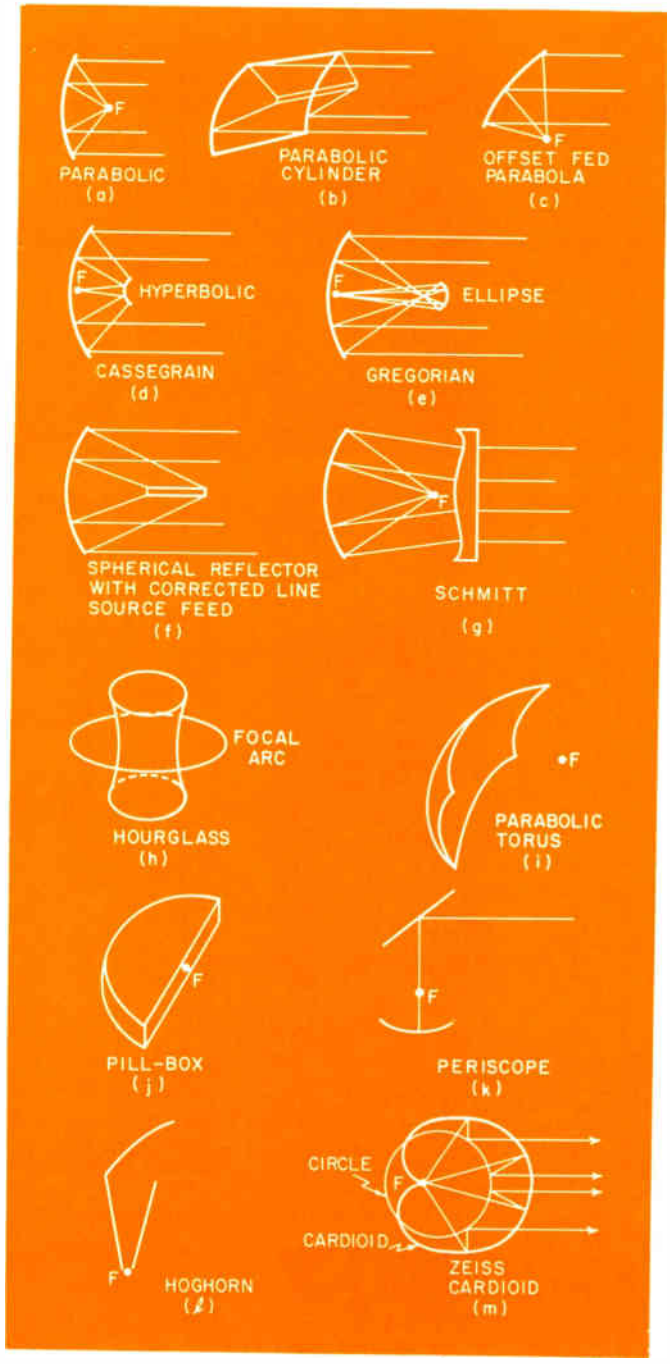

Fig. 1: Some of the possible antenna reflector forms.

IN GENERAL, the term aperture antenna is used to denote any antenna which radiates or receives energy from a well defined portion of its structure. All antennas have an "effective" aperture, this being a term which takes into account the efficiency.[1]

Essentially it defines an area which, when operating at 100% efficiency, is equivalent to the radiating portion of an antenna. "Effective" aperture is a useful term because many antennas, such as the dipole, rhombic, helical, loop, yagi, etc. (all described in accompanying articles), do not have a well defined radiating area. Hence, to be more specific in the definition of aperture antennas, the term will be used for antennas for which the "effective" aperture has about the same dimensions as the physical radiating aperture. Antennas in this class, are generally large in terms of the operating wave length, such as reflector antennas, horns, lenses, and surface and leaky wave antennas.

Reflector Antennas

The reflector type antenna can be considered as the work horse of the antenna industry. Some of its possible forms are seen in Fig. 1, which shows the simple reflecting system, the two reflector systems, the combination systems, i.e., reflector-lens (Schmitt), reflector-horn, etc. The reflector can be designed to yield pencil beams, fan beams and specially shaped beams, such as the cosecant pattern used for ground mapping. Reflector sizes vary from a few inches, used in the millimeter and sub-millimeter wavelength region to 1000 ft in diameter.

The usable frequency range of reflecting systems depends upon the accuracy of the reflecting surface. The reflector should not deviate more than $\lambda/16$ from the theoretical surface to realize close to calculated gain. This factor limits the size of a reflector for a given

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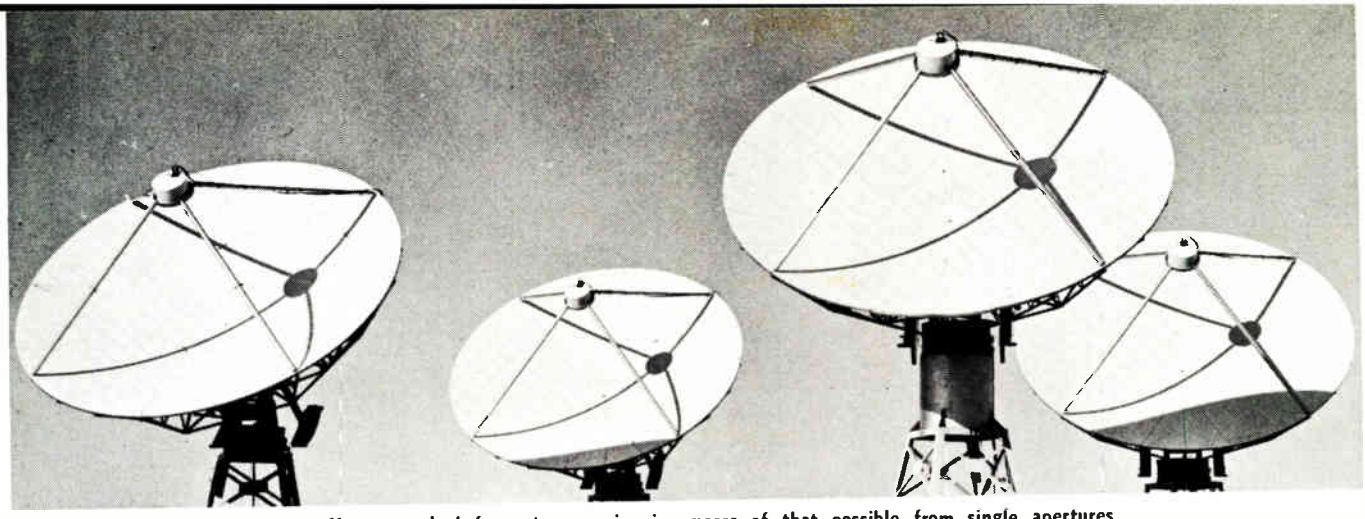


Fig. 2: Multi-reflector systems offer a method for antenna gains in excess of that possible from single apertures.

operating wavelength and hence the gain. The maximum gain from a single antenna has been from a 135 ft diameter parabolic reflector operating at 10GC, and was about 70db.[2] This represents the state-of-the-art in large reflector systems. Multi-reflector systems, as in Fig. 2, offer a method for antenna gains in excess of that from single apertures.[3]

The effective aperture of reflector antennas is about 50% of the physical radiating aperture.[4] The efficiency of a reflector depends, in part, on the design of the feed antenna. This customarily is a horn type antenna. The feed also determines the power handling capacity of a reflector (up to 100KW cw, 10 megawatts peak), the polarization properties, which can vary from linear through elliptical to circular, the side and back lobe levels (40 db-60 db)[5] and the noise temperature (low as 9.5°K).[6, 7]

Since the reflector is not frequency dependent, its bandwidth can be large (50% of the operating frequency) and depends in large part upon the type of feed used. Small reflector antennas are usually made by metal spinning methods and hence can be made cheaply. Highly accurate reflectors from 5 ft up to about 30 ft in diameter have been made using spin-casting methods, shown in Fig 3. This method is expensive, but furnishes a way of making larger reflectors with near optical qualities. Reflectors for lower frequencies (up to 20 GC) from 15 ft in diameter upward are usually built in pie-sections and are assembled using swing-templates or optical target surveying. Relative cost of such reflectors varies about in proportion to the cube of the diameter up to 85 ft, and to higher exponents for larger reflectors.

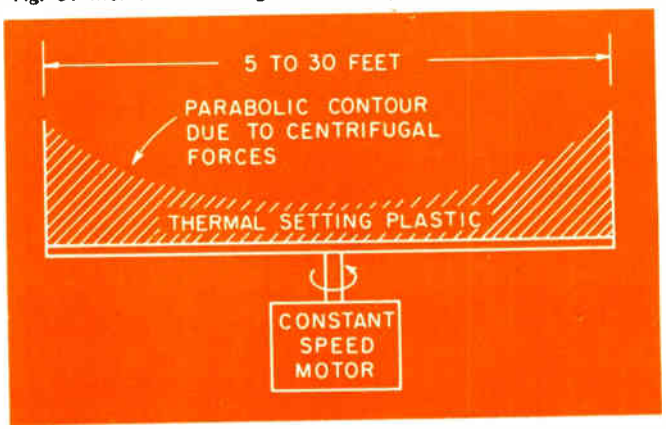
Horns

Horn antennas are widely used. The reason is that their dimensions are generally non-critical. Also, they are easily designed to give a wide variety of beam-shapes over very broad frequency bands.[8] They may be made in many shapes to control their three major properties: gain, radiation patterns, and impedance. A particular type of horn may be picked because of its ability to transmit certain desired modes or polarizations.

Some horn types are shown in Fig. 4. Generally, the horn is fed from a waveguide and hence, is most often used in the microwave band. The pyramidal horn is most commonly used as a gain standard because its gain can be calculated to within a tenth of a decibel if it is carefully built.[9] The radiation patterns have been investigated as a function of the horn length and flare angle in the E and H planes. [10] The patterns in the two planes are essentially independent, and hence, can be separately controlled. Efforts to reduce the lobing problems in the E-plane caused by diffraction at the horn aperture have been very successful. This has resulted in E-plane pattern approaching the H-plane patterns for any flare angle or horn length,[11] hence, causing the noise temperature of a horn to be that due to thermal energy radiated into the single main beam pattern.

The sectoral horns are special cases of two pyramidal horns where a fan beam is needed. The conical horn, by virtue of its symmetry, can handle any polarization, with the pattern again set by the horn length and flare angle.[12] The biconical horn is useful in the UHF-VHF bands for omnidirectional patterns, with independent control of the vertical plane pattern obtained from the flare angle and length of the horn.[13] By suitable feeding, either vertical or horizontal polarization can be obtained. The compound horn is used mainly where a good, broadband impedance match is needed. This is

Fig. 3: Method of making reflectors by spin-casting.



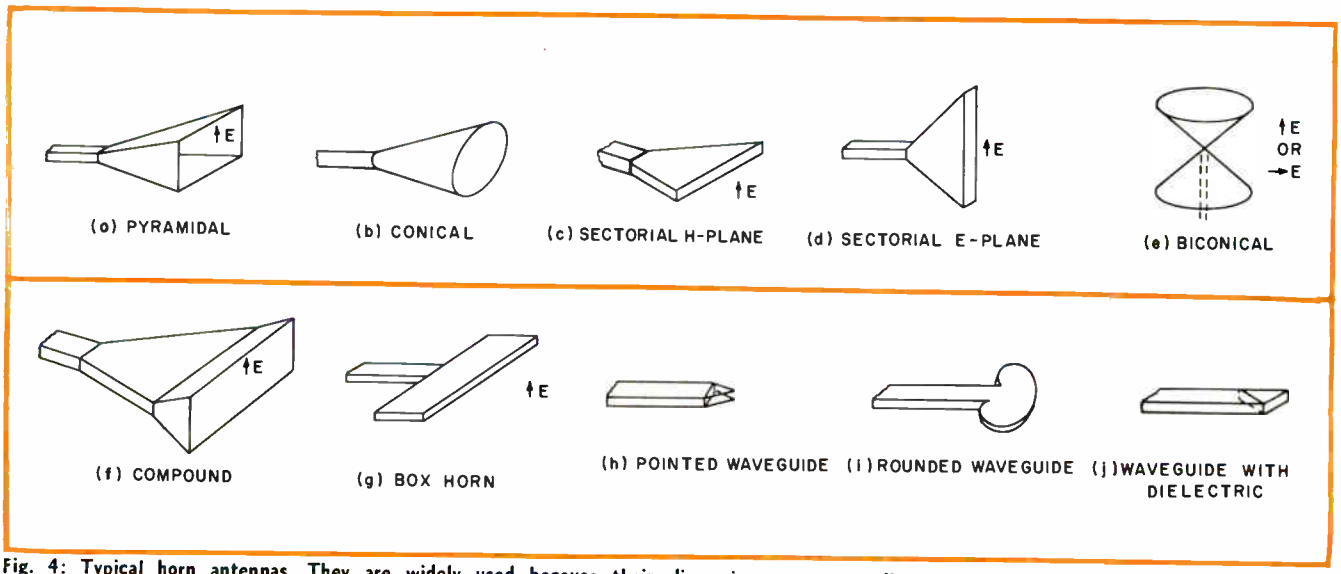


Fig. 4: Typical horn antennas. They are widely used because their dimensions are generally non-critical.

APERTURE ANTENNAS (Continued)

done by proportioning the E-plane flare angle horn length.[14]

The box horn is often used in place of the H-plane sectoral horn because it gives a narrower pattern in the H-plane for the same overall dimensions.[15, 16] Control of the H-plane pattern is obtained with the geometries shown in Fig. 4 h-j.

The power handling capability of horns is the same as that quoted for reflector antennas since they serve as feeds for the reflectors. The impedance of sectoral E-plane horns vary with horn length between a VSWR of 1.05 and 1.5; sectoral H-plane horns have a VSWR of typically 1.1 or less: pyramidal horns having a gain in excess of 20 db have a VSWR on the order of 1.03; and conical horns with moderate flare angles and gains in excess of 20 db have a VSWR of about 1.1-1.2.[17] The effective aperture of horns is normally 35% to 70% of the physical aperture.

Corner Reflector

As the name implies, a corner reflector is a special case of a reflector antenna, and is most often used when an aperture of 1 to 2 wavelengths is adequate.[18] For larger apertures, the parabolic reflector is the better choice. The corner reflector is attractive because it is made of flat reflectors, and hence is relatively inexpensive to make.

The method of images can be used to analyze a corner reflector for angles of 180° n, where n is an integer. Corner reflectors of intermediate angles cannot be treated in this way, but results can be interpolated from the others. Fig 5 shows the 45°, 60°, 90°, and 180° corners with the driven element and the images of the proper phases. The length L of the corner reflector depends upon the corner angle, and is smaller for the larger corner angles and vice versa. For a 90° corner, L should be about twice the spacing S of the driver from the corner. The height H of the reflectors should be about 2λ or larger.[19]

The spacing S has a major influence on the patterns of the corner reflector, as well as its impedance and bandwidth. Too small a spacing gives very low impedance and narrow bandwidth, quantitative results depend upon the corner angle. The patterns and impedance of corner reflectors are shown in Fig. 6. The trend in the patterns as the spacing S increases is the same for all corner angles; that is a single lobe is obtained for a close spacing range and as S increases, the single lobe splits and then recombines into a more directive beam (higher gain) with side lobes as S increases further. The higher gain condition represents a higher mode of operation. This is often desirable if the larger physical dimensions can be tolerated.

A 90° corner makes a good radar target, as it reflects all energy back in the direction from which it came.

Luneberg Lens

Microwave lenses are the electrical counterpart of optical lenses, where dielectric materials are used in place of optical glass. One of the most interesting, and perhaps the most widely used is the Luneberg lens.[20] In its original form, it consists of a spherical lens of dielectric material. The lens has the property that an incoming plane wave front will be focussed at a point on the spherical surface at a point diametrically opposite to where the wavefront was incident. Since the lens is spherically symmetric, it has no preferred directions of operation.

To do this focussing, the index refraction n varies in a radial direction according to the relation $n^2 = 2\text{-}r^2$ for a unit radius sphere. At the surface of the sphere the index of refraction is unity so that no reflection occurs at the air-lens surface. This factor becomes important for impedance and efficiency. The variation in refractive index for spherical lenses is done

by artificially loading a homogeneous dielectric with small glass or dielectric spheres or by making the lens in spherical shells, with the refractive index varying from shell to shell.

An important breakthrough has been the two dimensional Luneberg lens. It easily lends itself to flush mounting. In this type of lens, the variation in refractive index is the same as for the spherical lens, but techniques such as surface waves in dielectric sheets, [21], [22] corrugated surfaces, parallel plate waveguides and geodesic surfaces[23] have been used with good success. A further refinement has been in moving the point of focus from the surface to a circle interior to the lens. This permits a much reduced scanning radius, thus yielding mechanical advantages. Much work has been done in achieving control over the vertical position of the beam from a two dimensional lens and has met with good success.

In addition to serving as a wide angle scanning antenna, the Luneberg lens does well as a radar reflector when a metallic cap is placed on the lens.

The power handling capacity of a dielectric lens is severely limited due to the insulating properties of the dielectric materials. This is customarily a foam type material. The side and back lobe levels are directly dependent upon the feed design. The three dimensional lens has polarization characteristics which correspond with the type of feed used, while two dimensional lenses accept principally one sense of linear polarization, due to the techniques used to gain control over the refractive index. For two dimensional geodesic lenses which use the TEM mode, orthogonal linear polarization operation can be obtained.[24]

Traveling Wave Antennas

Two of the most familiar traveling wave antennas are the surface-wave and leaky-wave antennas, which cover a wide variety of structures. These antennas are usually several wavelengths long. Hence, the structure becomes large at the lower frequencies. As a result, they are used in and slightly below the microwave regions.[25]

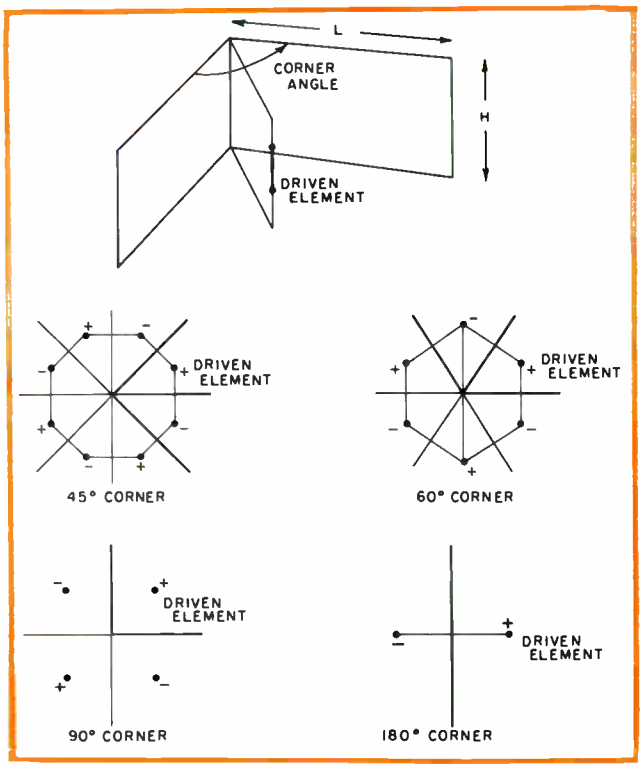
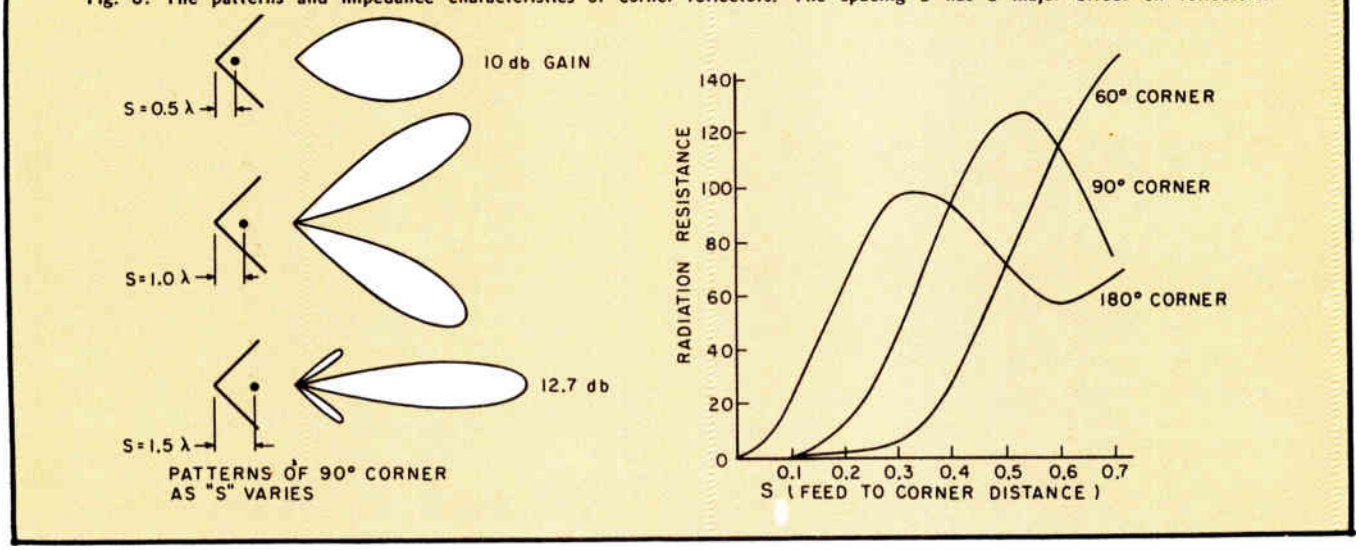


Fig. 5: Corner reflectors are a special case of reflector ant.

A surface wave antenna is characterized by a structure which supports a surface wave and radiates only at points of discontinuity. An example is the polyrod or dielectric rod, shown in Fig. 8a. The radiation pattern, usually endfire, is due to a combination of direct radiation from the feed and surface-wave radiation from the discontinuity at the end of the rod. Such end-fire surface wave antennas can be made of dielectric material or of artificial dielectrics, such as corrugated surfaces shown in Fig. 8b.

A leaky-wave antenna is a traveling wave antenna

Fig. 6: The patterns and impedance characteristics of corner reflectors. The spacing S has a major effect on reflectors.



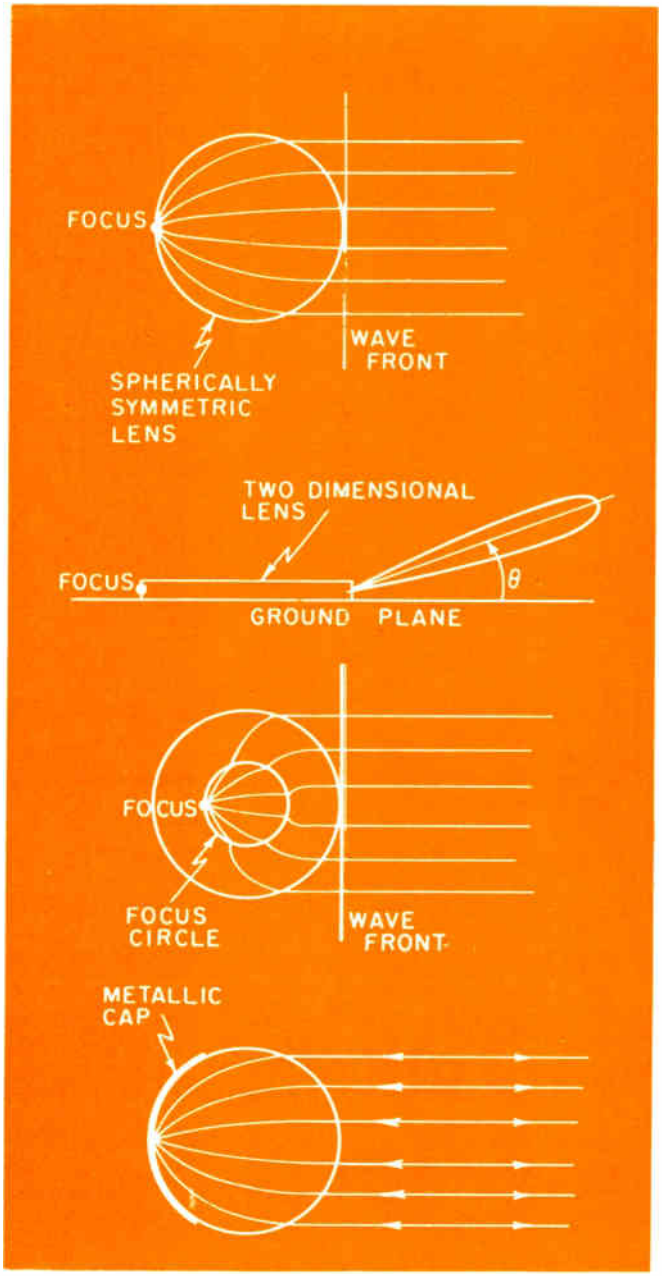
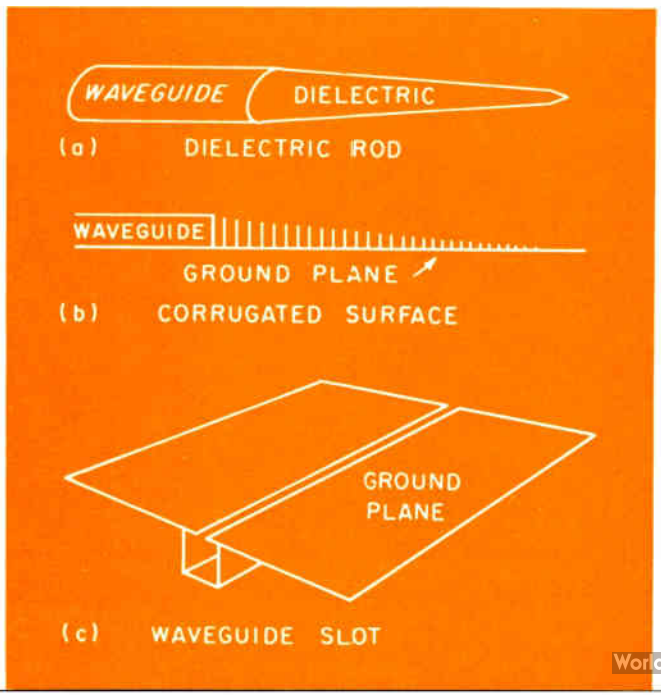


Fig. 7: Luneberg lens is a spherical lens of dielectric material.

Fig. 8: Traveling-wave antennas are useful for low silhouette.



that has many discontinuities per wavelength, and hence, radiates continuously along its length. An example is the waveguide slot, shown in Fig. 8c which is a continuous perturbing structure. Because the wave radiates continually, it is called a leaky wave. Most leaky-wave antennas can be mounted on curved surfaces such as aircraft wings, etc., can be frequency scanned from near broadside to near endfire without beam broadening, and can be easily designed to give desired patterns.

Both surface-wave and leaky-wave antennas lend themselves to low-silhouette installations, have bandwidths on the order of ± 15% with some approaching 2:1, and they are easily impedance matched. Airborne and missile uses include communications, search radar, command guidance, ground mapping and homing.

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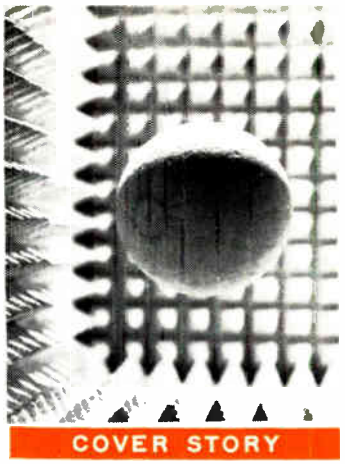


COVER STORY

New Developments In Luneberg Lenses

Recent advances in the design and construction of Luneberg lenses assure them an expanded role in diverse systems. Two of these developments will make them particularly useful in microwave systems.

THE SPHERICALLY-SYMMETRIC LUNEBERG LENS has been applied in systems ranging from large-aperture receiving antennas to small-diameter passive reflectors (see cover photo).

Two new developments will be of primary importance to their future uses in microwave systems: (1) the high-efficiency, lightweight artificial dielectric material, and (2) the continuous variable (in index of refraction) lens medium. Both have been used separately in various structures. They have also been combined in both two-dimensional (cylindrical) and three-dimensional (spherical) lenses. The latter may be built using families of short-cylinder modules. They can also be made by converting two-dimensional lenses into identical wedge modules and assembling them in "orange slice" fashion. A similarly graded central core is optional in such modular lens.

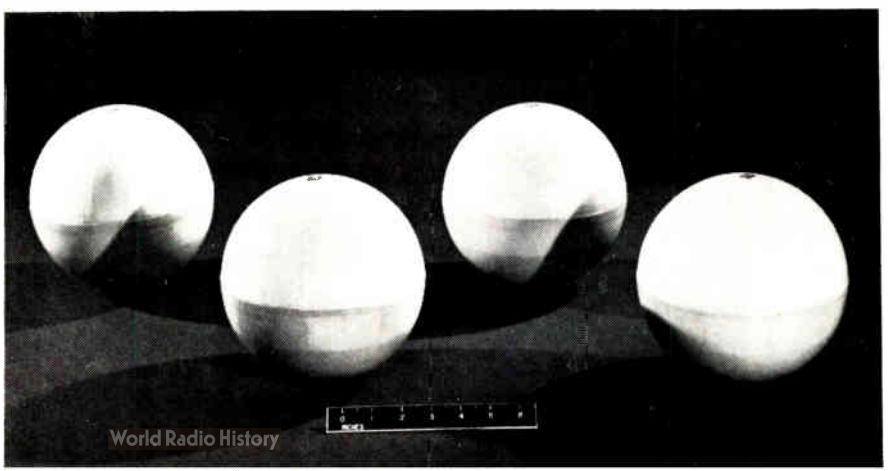
Two-dimensional Luneberg lenses are useful in azimuth scanning and wide-angle applications. Spherical lenses may be used for both elevation and azimuth scanning, and to provide conical angle coverage. A focal surface exists coincidentally with the physical surface. The infinite sphere (or cylinder) is imaged exactly on the respective lens surface. Reciprocally, a source placed on the lens' surface will have its wavefront transformed into a plane wavefront upon emergence from the lens. A line source is an appropriate primary radiator for a two-dimensional lens, and a point source is used with a spherical lens. Directional antennas, which may be scanned by electronic or simple mechanical means, are the result.

In passive reflector uses, the lens acquires the incident signal, which is brought to focus near the surface at a point diametrically opposite the point of normal incidence. A conductive surface placed on the lens' surface near the focus reflects the signal. The signal is then collimated and returned in the direction of the illuminating source. A wide-angle back-scatterer is achieved by use of a sectoral reflecting cap. The angle of coverage is that solid angle subtended by the cap. Large radar cross-sections may be achieved in this fashion. Such devices are useful for identification in environments having inherent low back-scatter features.

Beyond the ideal geometry and the obvious advantages which accrue over normal aperture antennas, the electrical characteristics of the Luneberg lenses are of primary interest. Existence of the focus on the reverse side of the radiating aperture assures an unblocked view. Also, use of the feed system on the lens' surface provides maximum aperture radiation and minimum undesirable direct feed radiation. (Note that the requirements for minimum aperture blocking and minimum direct feed radiation are conflicting in antennas using parabolic reflectors.) But, most advantageous is the radially-symmetric index of refraction which varies from a value of $\sqrt{2}$ at the lens center to unity at the surface; thus, the lens is matched to space and provides reflection-free performance.

Both natural dielectrics and the more easily manipulated artificial dielectrics are available as low-loss materials. They are both useful in the construction of lenses. The artificial ones are easily contrived using insulated metallic particles and pre-foamed plastic granules, to provide in a Luneberg lens a mean-effective dielectric loss of not greater than 0.0004 (loss tangent) at X-band frequencies. Also, artificial dielectrics have low densities (1 to 3 lb./ft.^{3}), and make possible construction of very lightweight antenna structures.

Microwave reflectors employing Luneberg lenses



By R. L. HORST,
Armstrong Cork Co.,
Lancaster, Pa.

LOG-PERIODIC ANTENNAS

Log-periodic antennas are relatively new. They find application where frequency independent antennas are required. The LP dipole array and the conical logarithmic spiral antenna have been the subject of extensive research.

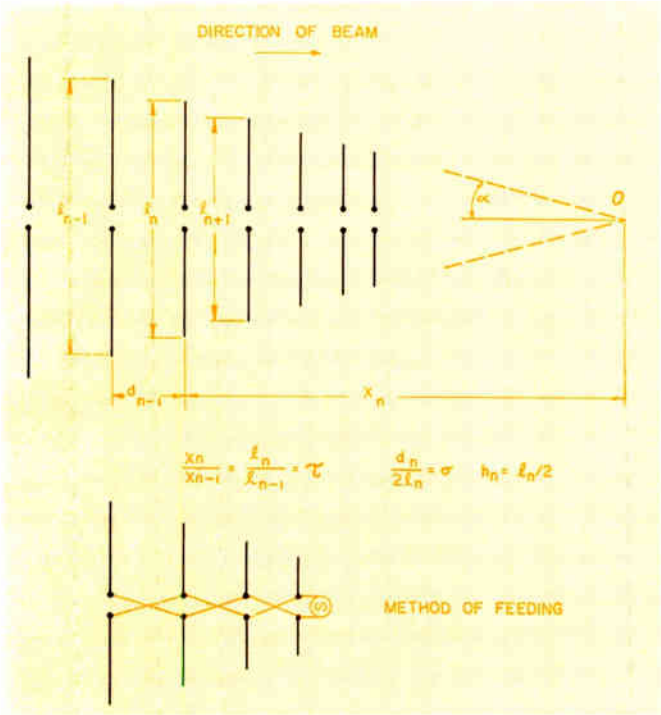


Fig. 1: A schematic of the LP antenna, with symbols used.

THE LOG-PERIODIC (LP) ANTENNAS belong to a unique class of radiating structures whose far-field pattern and impedance bandwidth can, theoretically, be made as large as wanted. The limitations being the size of the front and end truncations, and construction accuracy. Of course proper design is required to make the antenna performance meet the specified tolerance limits on the

Fig. 2: Computed E-plane half-power beamwidth vs. τ and σ.

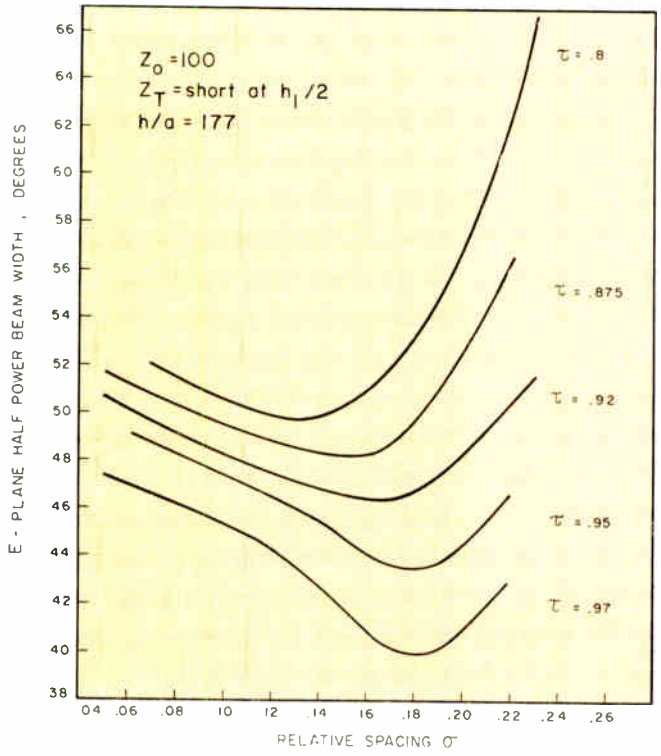
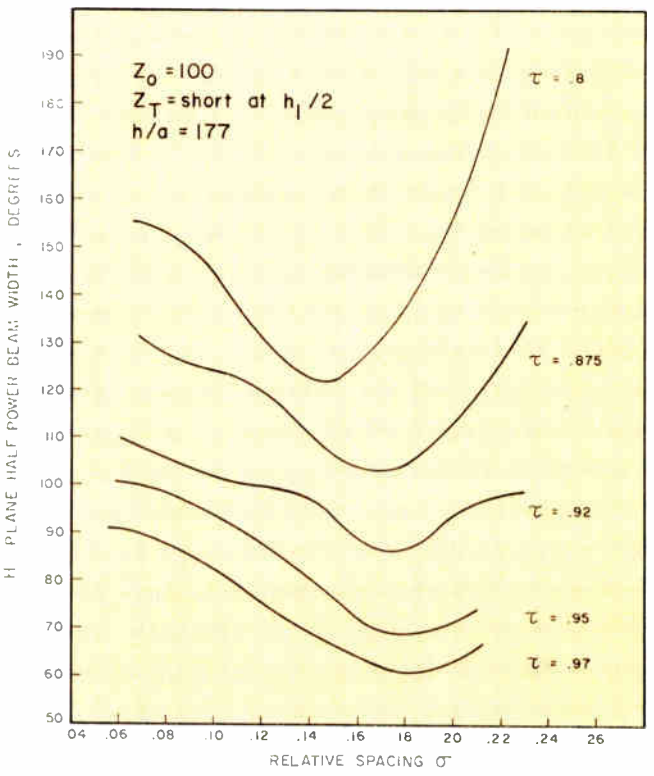


Fig. 3: Computed H-plane half-power beamwidth vs. τ and σ.



impedance and pattern variations. Not all of the structures satisfying the log-periodic conditions turn out to be broadband. However, many LP antennas have been built for versatile applications, and the success of the fundamental concept of LP design, introduced by Rumsey[1] and DuHamel and Ishell[2], has been well shown.

Some properties of a few well established LP antennas will be discussed briefly, and their design and performance data are given.

Two LP antennas for which extensive studies have been carried out are: 1. the LP dipole array; 2. the conical logarithmic spiral antenna. These are discussed below. Certain other LP antennas, for which only partial design data are available, are mentioned briefly.

Log-Periodic Dipole Array

One of the most popular LP antennas is the LP dipole array (LPDA). The data here have been extracted from the results of much investigation by Carrel[3].

By DR. R. MITTRA and DR. J. D. DYSON

Antenna Laboratory, Dept. of E. E.
The University of Illinois, Urbana, Ill.

Description: The drawing of the LPDA is shown in Fig. 1. This linearly polarized antenna is built by arraying a series of dipoles of sequential length l_n satisfying the LP criterion $l_n = l_n\tau^n$, where n is a positive or negative integer and l_n is a reference length. The elements of the array are fed by a two-wire transmission line. The feed connecting the adjacent elements is alternated to introduce the excess phase shift needed for operation. The quantity $\sigma = d_n/2l_n$, where d_n is the element spacing (see Fig. 1), is an important design parameter as is the log-periodic ratio τ. Note that σ is independent of n, since d_n's also satisfy the LP criterion.

Applicable Frequency Range: It is theoretically possible to achieve arbitrarily large bandwidths using the LP design principle. But, the accuracy of construction limits the highest frequency of operation. The dipole sizes and the distance between the elements may become too small toward the input end to build with enough accuracy. Also, the requirement that the feeder line cross-section be small compared to the length of the elements may not be achievable. The high frequency limit can be extended somewhat by using a tapered feeder, at least toward the feed end. The highest frequency of operation probably cannot be extended above 10 or 12 GC (or so) without much effort.

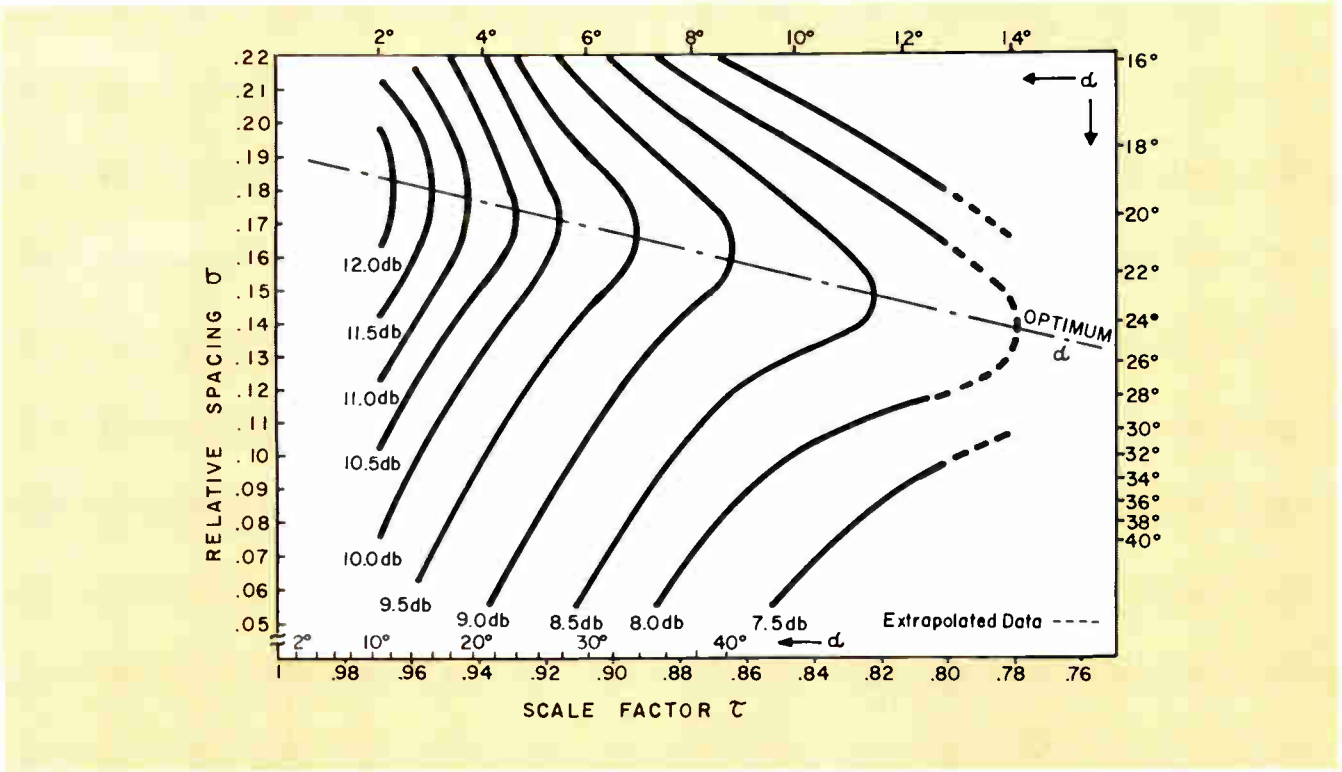
The lowest frequency is governed by the limitation on the maximum size. Environmental conditions also play an important part. For instance, one might be limited by the height of the LPDA above the ground when using it for communications. The presence of other obstacles near the antenna may also affect its low frequency performance.

It is not uncommon, to design a LPDA for a bandwidth of 10:1 or higher. The bandwidth of a given antenna may be obtained from the following:

$$\text{Bandwidth} = 300\,(K_1/l_1 - K_2/l_2)$$

where l_1, l_2 are the lengths (in meters) of the longest and shortest elements, respectively. Also K_1 is the low

Fig. 4: Computed log-periodic contours of constant directivity (D) vs τ, σ, and α.



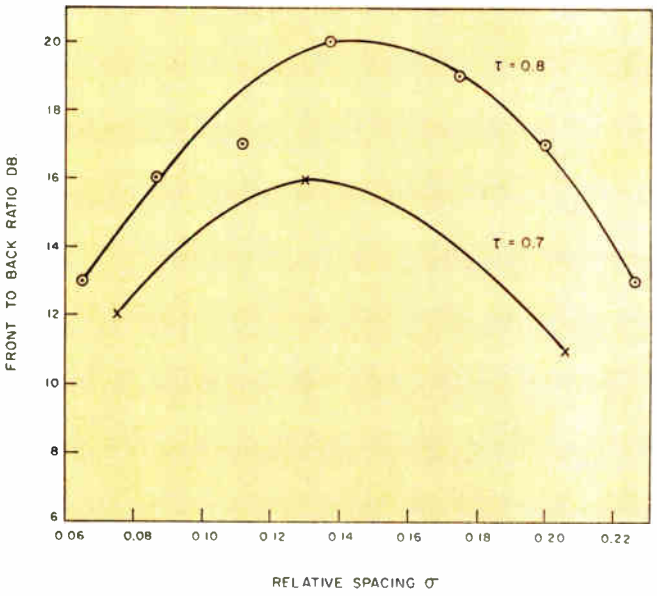


Fig. 5: Computed LP pattern front-to-back ratio vs. τ and σ.

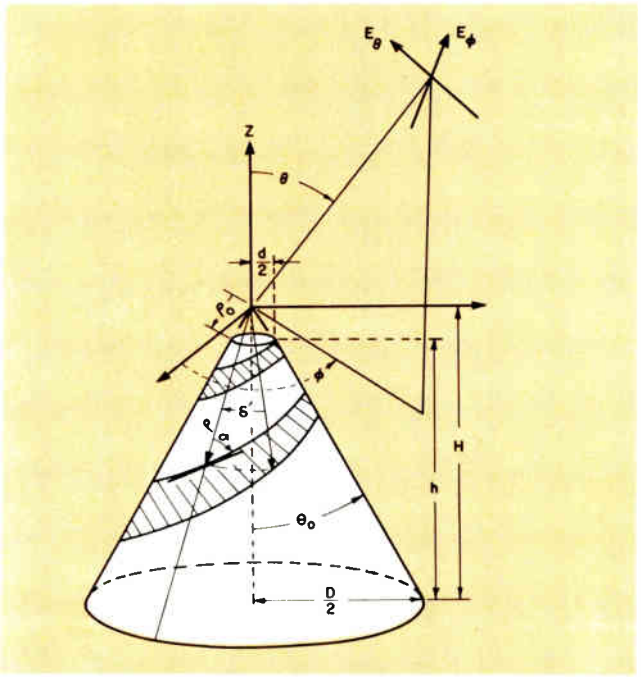


Fig. 6: The basic parameters of the 2 arm balanced conical.

frequency and K_2 is the high frequency truncation constant, which are dependent on σ and τ. Typically, K_1 ranges between 0.6 and 0.4 and K_2 varies from 0.24 to 0.42.

Gain and Beamwidth: The scale factor τ and the relative spacing σ exercise primary control over the shape of the radiation patterns of the LPDA.

The directivity D may be obtained from an accepted approximate formula[4]:

$$D = \frac{41253}{(BW)_E\,(BW)_H}$$

where $(BW)_E$ and $(BW)_H$ are half-power beamwidths in degrees.

Fig. 2 and 3 show the plots of these beamwidths with σ and τ as parameters. These curves may then be used to compute D, which is shown in Fig. 4. For convenience, the angle α (see Fig. 1) is also plotted. The range of directivity is about 7.5 to 12 db.

Side and Back Lobe Levels: With proper design, the only major secondary lobe in the LPDA pattern is the back lobe. Hence, we shall only consider the front-to-back ratio F/B. This ratio is plotted in Fig. 5 as a function of τ and σ. For $\tau > 0.875$ this ratio is greater than 20 db. For $\tau < 0.875$, this radio depends on σ and attains a maximum for σ near the optimum value shown in Fig. 4. Also, this ratio decreases as you approach the ends of the band.

Input Impedance: The input impedance of the LPDA is controllable over a wide range. The mean input impedance is resistive, and this resistance, says R_0, is given by

$$R_0 = Z_0 \left\{ 1 + \frac{Z_0\,\tau^{1/2}}{4\,Z_a\,\sigma} \right\}^{1/2}$$

where Z_0 = impedance of feeder line

and Z_a = characteristic impedance of the dipole antenna = $120\,l_n(l/a) - 2.25$

l = length of dipole element

a = radius of dipole element

It is assumed that the ratio l/a is constant for all elements, particularly near the feed end.

The upper limit of R_0 is determined by the problems of feeder construction, and values higher than 600 ohms are tough to achieve. Also, very low values of input impedance usually result in large truncation effects. Typical values of input impedance range from 35 to 200 ohms.

Bandwidth—Steady State and Transient: As pointed out, the steady state bandwidth can theoretically be made as large as wanted. Some limitations of achieving arbitrary large bandwidths were also pointed out.

The transient bandwidth of the LP antenna is much smaller than the steady state bandwidth because these structures are inherently dispersive. For further discussion of this point, refer to a paper by Mittra and Jones[5].

Conical Log-Spiral Antenna

Description: The basic parameters of the two arm balanced conical antenna are defined in Fig. 6. The parameter θ_0 determines the cone angle and α the rate of wrap of the arms. The angular width of the exponentially expanding arms is defined by the angle δ. This is the projection of δ' on a plane perpendicular to the axis of the antenna. These angles are constant for any given antenna and the radius vector to any point on the arms is given by:

$$\rho = \rho_0 \exp b(\phi - \sigma)$$

where

$$b = \frac{\sin \theta_0}{\tan \alpha}$$

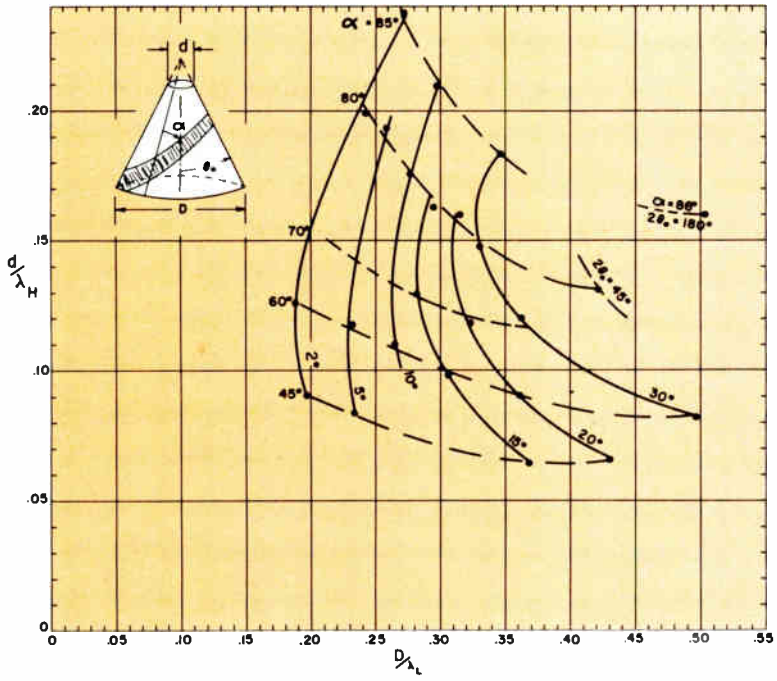


Fig. 7: The factors determining log-spiral antenna frequency ranges.

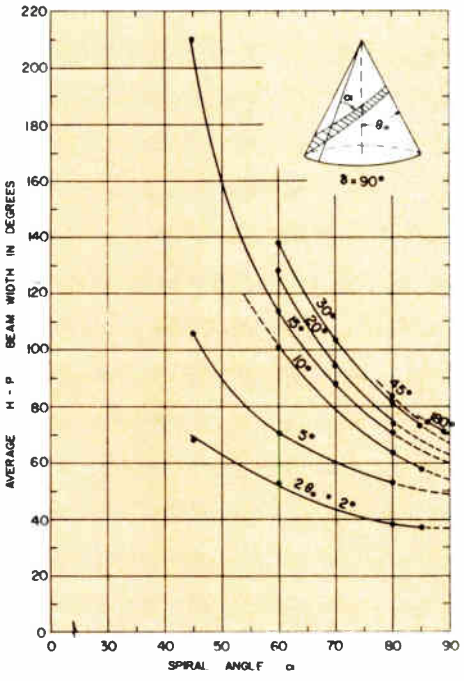


Fig. 8: Typical half-power beamwidths for conical

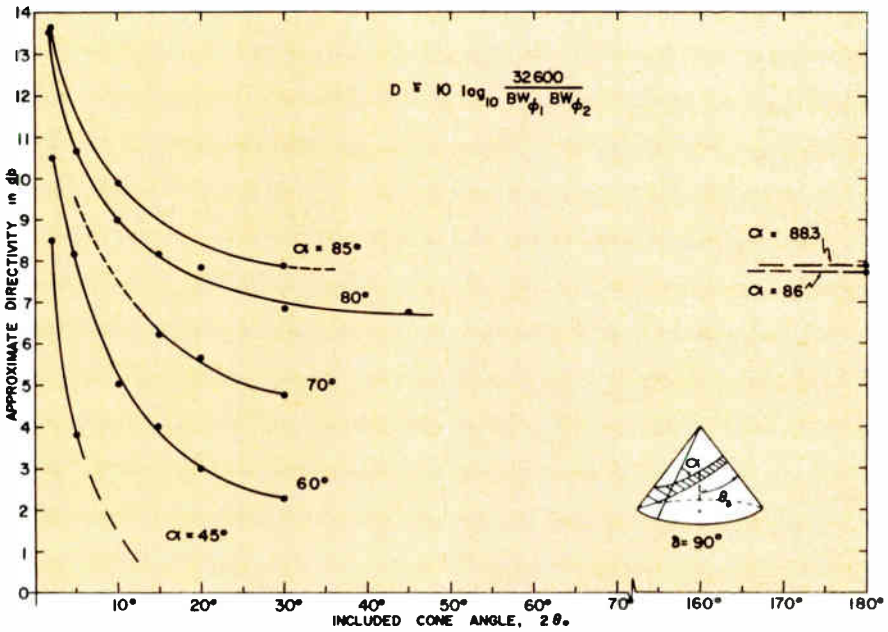
The edges of one arm are defined by letting $\delta = 0$, and a fixed value between 0 and π. The second arm is obtained by multiplying the defined equations for the first arm by $e^{-b\pi}$.

The antenna built with $\delta = 90°$ is of interest. This antenna is self complementary since the geometry of the metal arms and the space between the arms is identical, except for a rotation of 90° about the axis of the cone.

Antenna Size-Bandwidth Relation: The usable range of frequencies over which any practical log-spiral antenna may operate is determined by the size of the truncated apex and base of the cone. Fig. 7 shows the approximate required diameter of the apex in wavelengths at the highest frequency, and of the base in wavelengths at the lowest frequency of operation as a function of the cone angle θ_0 and spiral angle α. These limits apply to the self complementary antenna. For very narrow, or very wide arm widths, the base diameter D/λ_L must be increased by a factor that varies, from about 1.2 for $\alpha = 80°$ to 1.7 for $\alpha = 60°$.

Radiation Characteristics: The conical antenna radiates a unidirectional beam off the apex of the cone. Typical half-power beamwidths are shown in Fig. 8. The radiated far fields are elliptically and essentially circularly polarized in all directions where there is enough radiation. But, the fields are not perfectly circu-

Fig. 9: The approximate directivity of the conical log-spiral antenna over a circularly polarized isotropic source is shown.



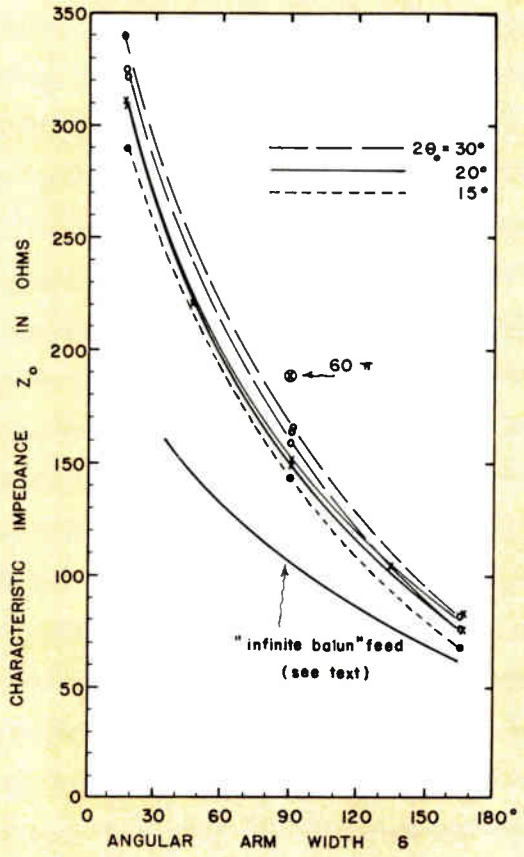


Fig. 10: The input impedance of the conical spiral antenna is mainly a function of the angular arm width.

LOG-PERIODIC ANTENNAS (Concluded)

lar polarized at all angles off the axis of the cone. Hence, there is 5 to 8° difference in the half-power beamwidth of patterns recorded with orthogonally oriented, linearly polarized receiving antennas. Also, there may be from a 4° to 20° variation around these average beamwidth as the antenna is used over wide bandwidths. Least variation occurs for large α.

The directivity-beamwidth relationship given earlier is sometimes too optimistic. A recent note by Stegen[6] indicates that the expression

$$D = 10 \log_{10} \frac{32600}{BW_{\phi 1} BW_{\phi 2}}$$

where the denominator is the product of the average half-power beamwidths in orthogonal planes, may be more realistic. Using this relationship, the approximate directivity of the conical log-spiral antennas, over a circularly polarized isotropic source, is shown in Fig. 9. This expression give a directivity about 1db less than that used in the LP dipole array.

For $2\theta_o \leqslant 30°$ and $\alpha \geqslant 60°$ these antennas have no major sidelobes when used within proper design limits. The front to back ratio of the radiated fields is a function of the spiral angle α, the arm width δ and, since the planar antenna ($2\theta_o = 180°$) is a bidirectional radiator, a function of the cone angle. For $2\theta_o \leqslant 25°$ and $\alpha \geqslant 70°$ the front to back ratio should be greater than 15 db. This value rapidly increases as θ_o decreases and α increases.

Input Impedance: The input impedance of the conical spiral antenna is mainly a function of the angular arm width. As shown in Fig. 10, it varies from about 320 ohms for the narrow arm structures to around 80 ohms for those with very wide arms. The impedance increases slightly with increasing α and increasing cone angle. The self complementary antennas approach the theoretically predicted value of 60π (Rumsey, loc. cit.).

These are balanced antennas and the impedances were measured for antennas excited by carrying a balanced feed line along the axis of the cone. If a coaxial line is carried along the arms, the so-called "infinite balun" feed, the presence of the cable gives the narrow arms at the apex a greater equivalent width and hence, the impedance level is shifted down as shown in Fig. 10. The one curve shown represents data measured for an antenna with $2\theta_o = 20°$, fed with a cable that had a diameter one-fifth that of the truncated cone apex.

Bandwidth: The comments made in regard to the steady-state and transient bandwidths of the LPDA antennas apply to the LP conical spiral antennas. Further information on the design of these may be found in two recent works.[7]

Other Log-Periodic Antennas

A large class of LP antennas have been developed and a survey and extensive bibliography of the early literature is available[8]. A complete description of these antennas is beyond the scope here. We shall merely mention here a few of the well-known ones. The various LP antennas may be grouped into the broad classes: (a) Free Space Models—(i) triangular tooth antenna, (ii) trapezoidal tooth antenna, (iii) Vee antenna, (iv) turnstile antenna, (v) zig-zag antenna, (vi) folded dipole antenna; (b) Ground Plane Models—(i) stub-loaded monopole antenna, (ii) bent zigzag antenna, (iii) coaxial fed monopole antennas; (c) Flush Mounted Models—(i) folded slot antennas, (ii) letter-rack antenna, (iii) cavity-backed slot antenna.

Details on most of these may be found in reports issued by the Antenna Laboratory of the University of Illinois. Some of the above antennas are also described in the design handbook of LP antennas[9].

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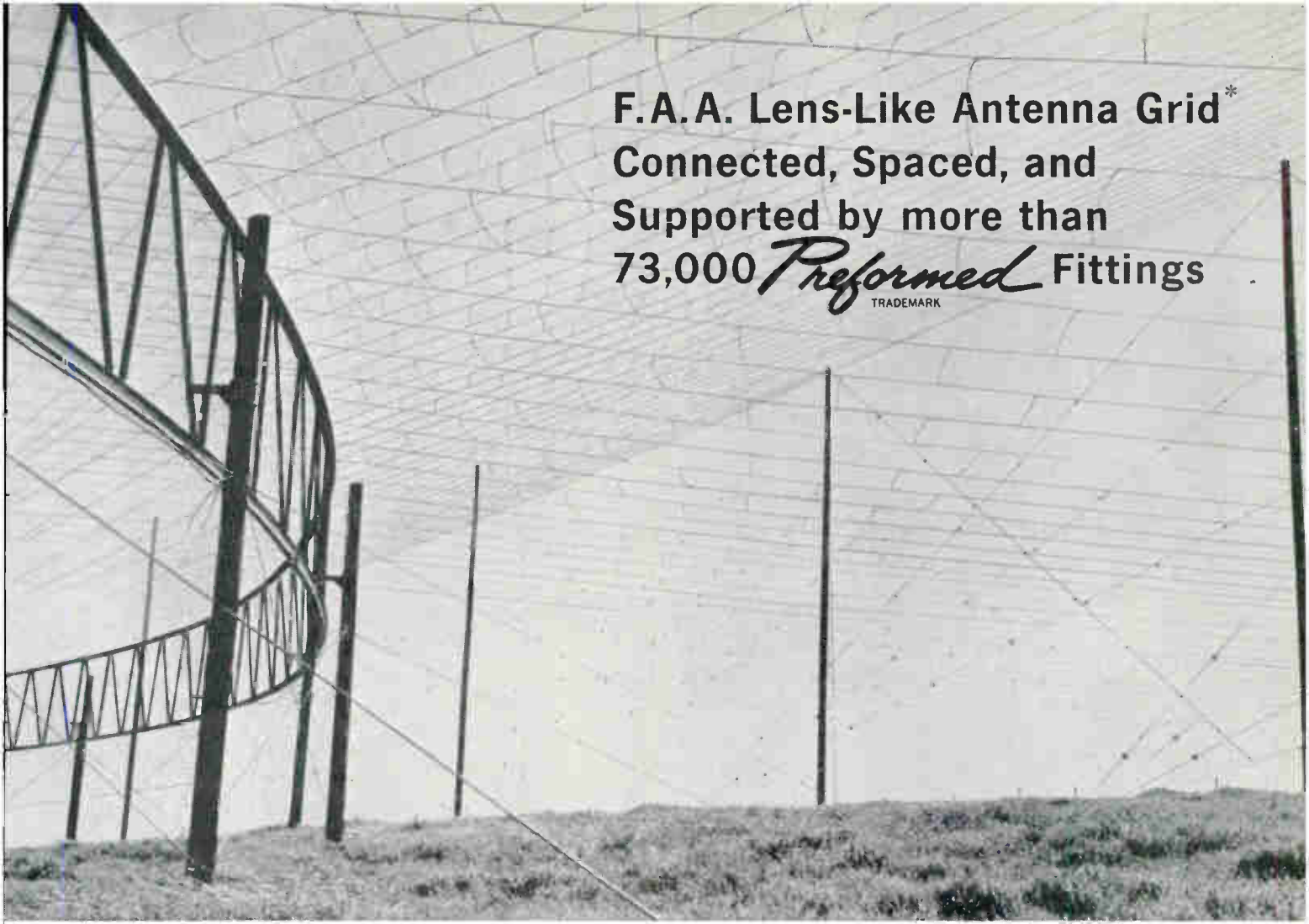

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Circle 46 on Inquiry Card

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HOFFMAN PLACE, HILLSIDE, NEW JERSEY

Using Field Effect Transistors for Digital Circuits

By HAROLD Y. WONG,
Senior Research Engineer,
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Sunnyvale, Calif.

Due to improvements in the dynamic characteristics of Field Effect Transistors they can now be used extensively in digital circuits. But, certain design criteria must be observed. This article presents some of these criteria and shows how a typical 3-stage counter can be logically designed.

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FEATURE

FIELD EFFECT TRANSISTORS (FET's)[1] are being increasingly accepted as one of the basic semi-conductor devices in circuit design. There has been a big improvement in their dynamic characteristics through new geometries and through planar, passivation and expitaxial methods. Because of this, FET's can now be used extensively in digital circuits.

When using FET's for digital circuits, especially in flip-flop design, one must understand how some FET parameters can affect circuit performance.

This article presents some design criteria one must observe when using FET's in counter design. It also shows how a typical 3-stage reversible counter can be mechanized in a logical manner.

* * *

Before proceeding in counter design, let's start with the basic building block, the flip-flop, Fig. 1.

One of the criteria in design is to make sure that the flip-flop is stable under a steady state condition. This means a bistable characteristic must exist. Because the FET's dynamic characteristics resemble those of the vacuum tube pentode, the bistability criterion[2] for the vacuum tube circuit may be used for the FET circuit. To guarantee that the FET flip-flop meets the bistability criterion, the following inequality must be satisfied:

$$Gm > \frac{R3 + R5}{R5}\left(\frac{1}{r_p} + \frac{1}{R1} + \frac{1}{R3 + R5}\right) \qquad (1)$$

where

Gm = transconductance of FET in μmhos.

r_p = dynamic on-resistance of FET in ohms.

All other designations are shown in Fig. 1.

For the selected Amelco FE300, typical Gm and r_p are 1700 μmhos and 1.5K ohms, respectively. If the power supplies are arbitrarily chosen to be plus and minus 22 v. With a 9.1K load resistor ($R1$) supplies will yield a drain current of about $I_d = 22/9.1\text{K}$ or 2.4 ma. $R3$ and $R5$ are chosen to be 33K and 61.9K, respectively. Substituting the numerical values into Eq. 1 yields:

$$1700\ (10^{-6}) > \frac{(33 + 61.9)\ (10^3)}{61.9\ (10^3)}\left(\frac{1}{1500} + \frac{1}{9100} + \frac{1}{(33 + 61.9)\ (10^3)}\right)$$

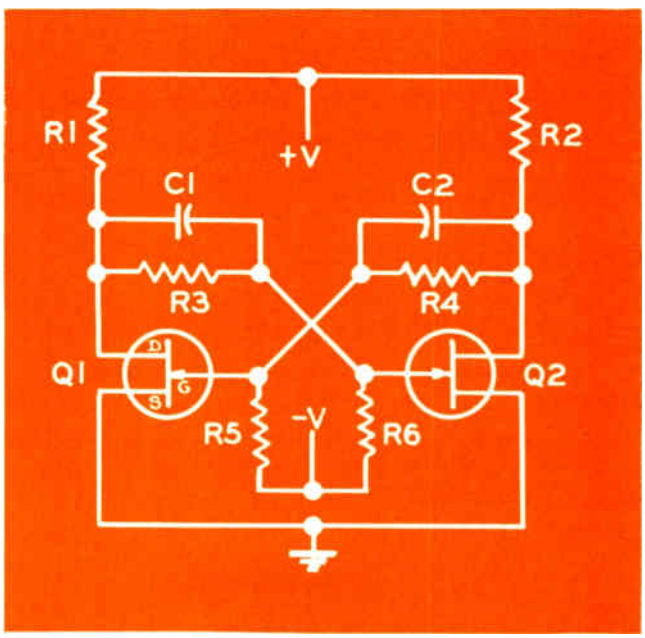
$$> 1.53\ (0.67 + 0.11 + 0.01)\ (10^{-3})$$

$$> 1209\ (10^{-6})$$

It can be seen that this inequality is now satisfied and thus the bistability is guaranteed.

(*Continued on following page*)

Fig. 1: Basic building block is the flip flop. Here R1=R2, R3=R4, R5=R6 and C1=C2. Q1 and Q2 are Amelco 300 (N-channel FET).



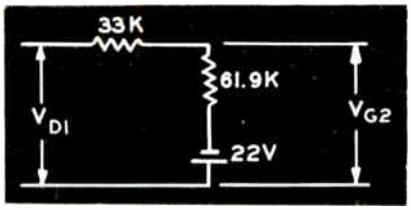


Fig. 2: Equivalent circuit for on-off condition.

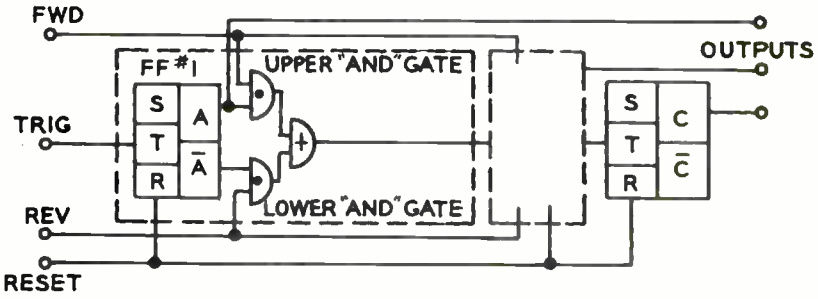


Fig. 3: The 3-stage reversible counter logic diagram.

Pinch-off Voltage

Next, pinch-off voltage of the off-transistor must be found. And, it should not exceed the specified maximum rating.

Assuming Q1 is conducting, the voltage at the junction of R1, C1, and R3 is about 1 v. The gate voltage, V_g2, of Q2 can now be calculated. The equivalent circuit for this on-off condition is shown in Fig. 2.

Where

$V_D1 = 1$ v, the calculated gate voltage of Q2 is

$$V_{g2} = \frac{1 + 22}{33 + 61.9}(61.9) - 22$$
$$= 15 - 22$$
$$= -7 \text{ v}$$

The typical pinch-off voltage for the FE300 is about −4.5 v. The absolute maximum is −10 v. Thus, the component values chosen are satisfactory, and the transistor is operated within a safety margin.

Logic Diagram

The next major step in reversible counter design is to lay out the logic diagram, Fig. 3.

The logic arrangement in Fig. 3 enables the counter to count either forward or reverse. Which direction it counts depends on the states of the forward and reverse lines. In practice, the forward or reverse, and trigger signals are obtained from the outputs of a steering flip-flop and a delay flip-flop respectively.

Operation

Theory of operation for the reversible counter can be briefly described as follows: Let the stable state of the forward and reverse lines be a binary "1" and "0," respectively. The counter may be reset by grounding the reset line momentarily. The delay flip-flop outputs always lag the steering outputs by a certain delay time. Because of this the steering outputs set the counter either in forward or reverse direction before the delay trigger signal arrives at the first flip-flop. When the negative delay trigger signal arrives at flip-flop No. 1, its stable state changes immediately regardless of the forward or reverse line's condition. But with the pre-set conditions imposed on the forward and reverse lines, only the upper AND gate will generate an output with the changed state of flip-flop No. 1. The lower AND gate will remain unchanged. The negative differentiated output from the upper AND gate is then coupled through the OR gate to trigger the next stage. Because each flip-flop changes state in a binary fashion, forward counting is achieved as long as the forward line is held at a binary "1" condition. But, if the forward and reverse lines are now changed to a binary "0" and "1," respectively, the lower AND gate will generate an output while the upper AND gate will remain unchanged. The output from the lower AND gate is again differentiated and coupled through the OR gate to trigger the next stage. This causes the counter to count in a reverse direction. The typical schematic for the basic diagram is shown in Fig. 4.

Table 1:

Truth Table for a 3-Stage Reversible Counter

FWD-REV state		Counter state at time t_0			Counter state at time t_{0+1}		
F	R	C	B	A	C	B	A
1	0	0	0	0	0	0	1
1	0	0	0	1	0	1	0
1	0	0	1	0	0	1	1
1	0	0	1	1	1	0	0
1	0	1	0	0	1	0	1
1	0	1	0	1	1	1	0
1	0	1	1	0	1	1	1
1	0	1	1	1	0	0	0
0	1	0	0	0	1	1	1
0	1	1	1	1	1	1	0
0	1	1	1	0	1	0	1
0	1	1	0	1	1	0	0
0	1	1	0	0	0	1	1
0	1	0	1	1	0	1	0
0	1	0	1	0	0	0	1
0	1	0	0	1	0	0	0

F = forward line
R = reverse line
A = least significant figure
C = most significant figure
t_0 and t_{0+1} represent the states of the flip-flop at two bit-time
Numbers in this table are regular binary 1's and 0's.

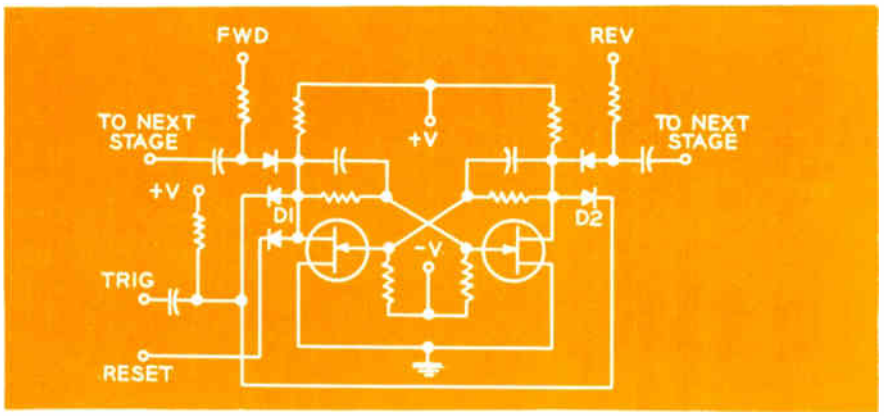


Fig. 4: Typical schematic for the logic diagram shown in Fig. 3.

Diodes D1 and D2 are steering diodes. They provide the means of coupling the trigger pulse effectively to that portion of the circuit which can be influenced by a negative pulse while at the same time isolating other parts of the circuit.

The voltage appearing on the forward line may be the same as +V, while on the reverse line it may be the same as −V. A complete 3-stage FET reversible counter is shown in Fig. 5. Its truth table is shown in Table 1.

Experiment showed that this reversible counter functioned satisfactorily from −10°F to +150°F with a rep rate of 2KC.

Conclusions

It can be seen that the counter design using FET's is feasible. But, several aspects in designing the flip-flops will have to be kept in mind. In general, triggering speed and trigger sensitivity should be high; power consumption and sensitivity to interferences should be low. Most of all, the flip-flop should have good stability. Because all these conditions cannot be satisfied at the same time, it is hard to form general rules for designing a bistable flip-flop. Thus, the take-and-give propositions must be considered by the designer to best suit the use.

An advantage of using FET's in counter design is that they can resist severe nuclear radiation. Since flip-flop stability depends on the constancy of the transconductance (Gm), experiment[3] shows that Gm of the N-channel FET's are essentially constant up to 10^{13} nvt.

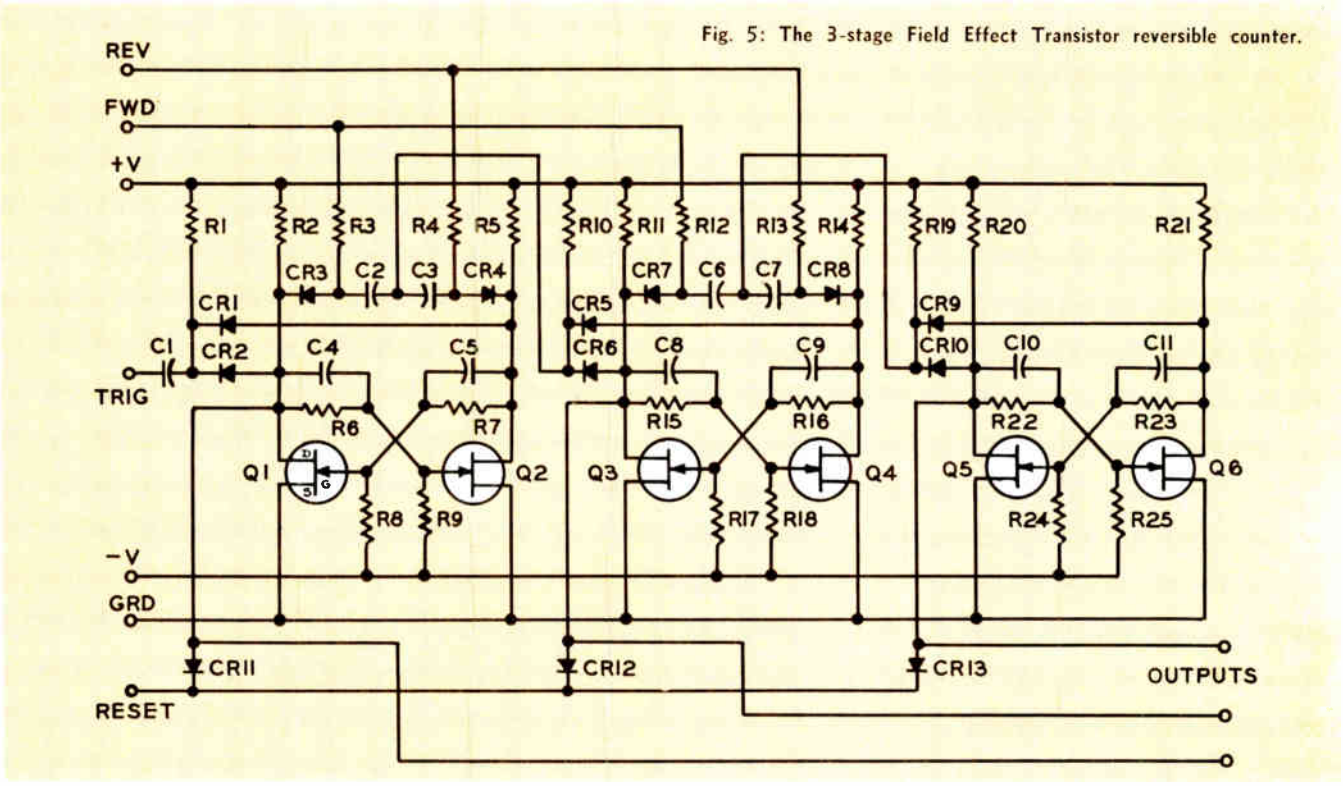
References

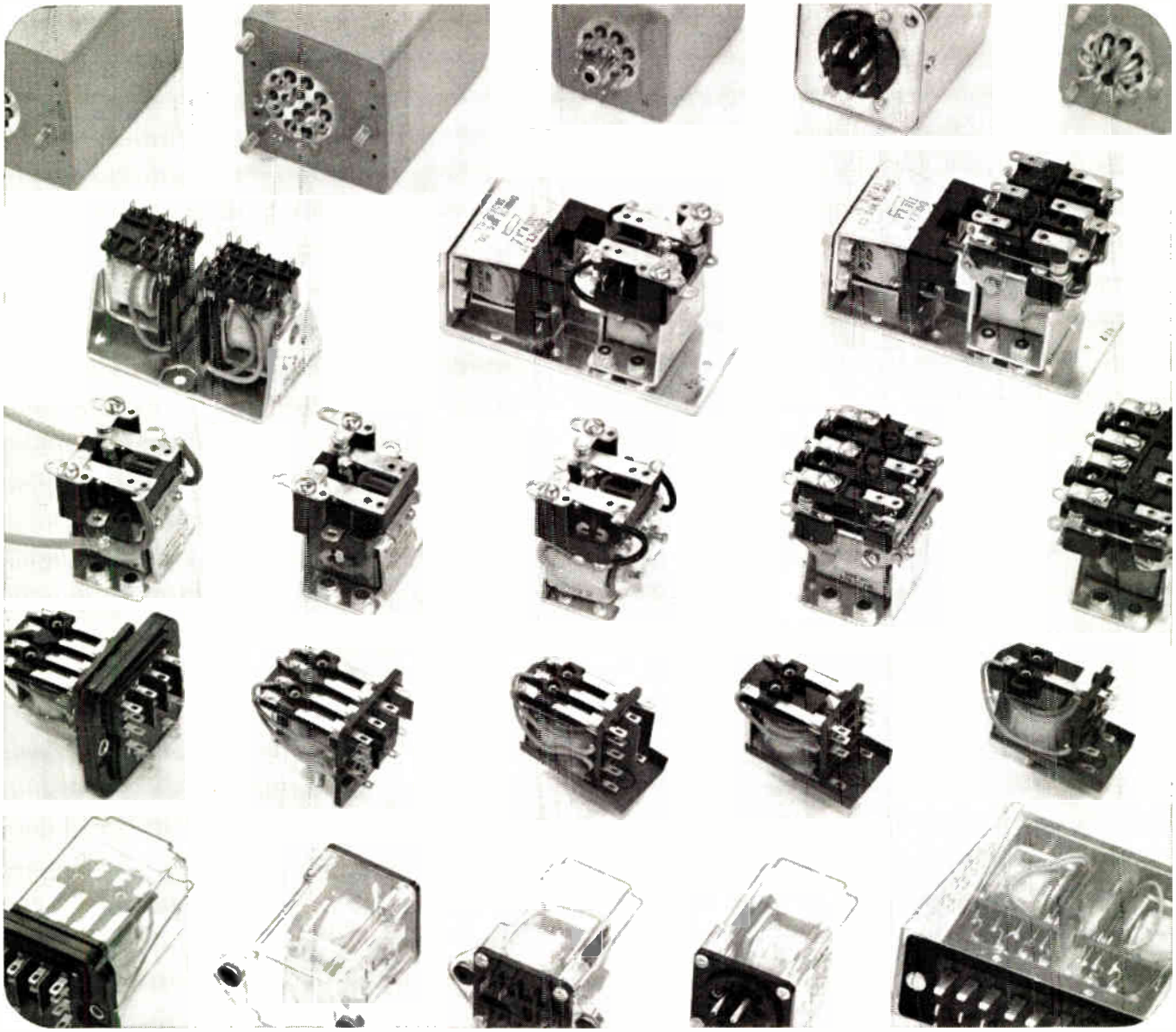
(1) Shockley, W., "A Unipolar Field-Effect Transistor," *Proceedings of the IRE*, Vol. 40, Nov., 1952.

(2) Reich, H. J., *Functional Circuits and Oscillators*. D. Van Nostrand Co., Inc., p. 116.

(3) Wong, H. Y., "An Experimental Investigation of Unipolar Field-Effect Transistors," *Master's thesis*, Univ. of Santa Clara, Sept. 1963.

Fig. 5: The 3-stage Field Effect Transistor reversible counter.





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Facilities Brochure

"Skill" in the title of this 30-page brochure from McDonnell Electronics. The brochure, in color, describes engineering facilities which have aided McDonnell in solving the complex problems encountered in the aircraft and aerospace industries. McDonnell Electronics Div., Dept. 946, Box 516, St. Louis, Mo.

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VOM Brochure

Brochure #2066 describes a volt-ohm-milliammeter which protects itself almost 100% against mistakes by the user. Called the 260-5P, it has more foolproof features than any other VOM now on the market, according to the manufacturer. The safeguards prevent serious damage such as burned out meters and resistors, bent pointers, damaged pivots, cracked jewels, and inaccuracies caused by overheating. Simpson Electric Co., 5200 W. Kinzie St., Chicago, Ill.

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Integrated Circuits

A 6-page brochure is available which describes the LU-Series Utilogic integrated circuits. The 7 circuits, priced at less than $1.50/gate function, provide 800 mv. noise margins. The brochure contains specs. and typical subsystem applications for the elements, which include AND and NOR gates, gate expander, and J-K F-F. Signetics Corp., 811 E. Arques Ave., Sunnyvale, Calif.

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I/C Modules

This data describes a line of digital modules that use monolithic integrated circuits. This product line provides digital system designers with all the logic elements necessary to build complete computer systems. Whittaker Corp., 9229 Sunset Blvd., Los Angeles, Calif.

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Flip-Chip Modules

This 202-page Flip Chip Module catalog describes a complete line of digital logic modules, and includes extensive material explaining their use. It covers more than 100 digital logic circuits and their accessories, with particular emphasis on R series (2MC) and B series (10MC) modules. A 37-page introduction explains basic digital logic. No experience in logical design is assumed and numerous examples of typical circuits are presented. A 27-page appendix provides background and reference material, such as explanations of digital and octal number systems, Boolean algebra, and bibliography of literature on digital logic. Digital Equipment Corp., 146 Main St., Maynard, Mass.

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Tunnel Diode Manual

This tunnel diode manual covers microwave, computer, detector and general purpose diodes. Ranges up to 50Gc are detailed. Complete performance specs. are listed. Printed in 3 colors, the manual color-codes diode uses to specs. for each of 3 types: germanium, gallium antimonide and gallium arsenide. Six varieties of hermetically sealed packages are described. KMC Semiconductor Corp., Parker Rd., R. D. 2, Long Valley, N. J.

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Semiconductor Guide

"Your Guide to Bendix Semiconductors" lists a wide range of semiconductor products by type number. Data contained within its 14 pages cover the operating ranges of each device. These devices include silicon planar epitaxial transistors, diffused alloy transistors, silicon diffused power rectifiers, military semiconductors, and Ignistors™. Schematics showing applications are included. Bendix Semiconductor Div., South St., Holmdel, N.J.

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Computer Tape

A series of booklets entitled, "Management Looks at Computer Tape" is a definitive survey of techniques for control of performance and life expectancy of computer tapes. The first of the 3-part series, subtitled, "The Technical View," is now available. It considers the physical characteristics of tape, as well as their significance in computer operations. General Kinetics Inc., 2611 Shirlington Rd., Arlington, Va.

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Circuit Bonder

Bulletin GED-4975A details features of a square pulse bonder for uniform surface bonding of leads to microminiature circuitry. Data includes electrode, applications, and specs. tables. In addition a discussion of welding head, positioning system, optical system and solid-state power control system are given. General Electric Co., Schenectady 5, N. Y.

Circle 138 on Inquiry Card

Silicon Diodes

Data is available on a new series of silicon molded diodes. The LMZ-LMZX zeners are recommended as low-cost replacements for uses up to 2w. They are available with voltages from 8.2 to 100. Their non-conductive epoxy bodies withstand Mil-S-19500 environmental needs. Temp. range is −55°C to 200°C. U. S. Semcor, Solid State Div., Nuclear Corp. of America, 3540 W. Osborn Rd., Phoenix, Ariz.

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Transformer Applications

Applications Engineering Notes on the design of unijunction transistor trigger circuits for SCR uses and SCR transformers are available. The application note on SCR transformers (Vol. 4, No. 4) discusses how these may be used with a unijunction transistor, making the trigger circuit sensitive to specific freqs. Application Note (Vol. 4, No. 5) covers the design of a unijunction transistor trigger circuit for SCR uses, and suggest that triggering is greatly improved by using a pulse transformer as opposed to resistance coupling. Aladdin Electronics, Nashville, Tenn.

Circle 140 on Inquiry Card

Yoke Catalog Sheet

This catalog lists 12 design features of the Type Y66 deflection yoke. It contains dimensional drawings, electrical and mechanical data, and 2 tables of coil data. The yoke is designed for 2⅛ in. neck dia. Charactron CRT's and precision displays. Syntronic Instruments, Inc., 100 Industrial Rd., Addison, Ill.

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Instruments Catalog

The 1965 catalog pictures and describes a line of VTVMs, dc/ac volt/ohmmeters, decade amplifiers, calibration, capacitance meters, converters, and laboratory standards. Prices are included. Ballantine Laboratories, Inc., P. O. Box 97, Boonton, N. J.

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Test Equipment Catalog

This short-form catalog describes system components and test equipment. It details, with complete specs., transistorized solid-state, hybrid and tube type i-f amplifiers. Test and noise measurement equipment are also described. Airborne Instruments Lab., div. of Cutler-Hammer, Deer Park, N. Y.

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IC Amplifiers

Data is available on 2 Solid Circuit® semiconductor networks in a new h-f line of integrated-circuit amplifiers. The SN5500 is a sense amplifier for magnetic-core memory uses; the SN5510 is a video differential amplifier. Diffused transistors in this series have an f_T to 1.2Gc under low-current and low V_{ce} conditions. This makes possible excellent h-f performance and low-power dissipation. Complex circuits are fabricated in single bars of silicon and packaged in ¼ x ⅛ in. flat packs. Complete operating specs. available from Texas Instruments Incorporated, Semiconductor-Components Div. P. O. Box 5012, Dallas, Texas.

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NEW TECH DATA

Oscilloscope

The 130C oscilloscope has a sensitivity of 200μv/cm, which eliminates preamps. Bandwidth is 500KC on all ranges. An internal graticule CRT eliminates parallax errors. It has a constant input impedance and balanced input on all ranges. Complete details are available from Hewlett-Packard Co., 1900 Garden of the Gods Rd., Colorado Springs, Colo.

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Microwave Absorber

Data is available on a high-temp. resonate-type microwave absorber capable of providing continuous performance at 500°. The material, Type RF-HT, is a lightweight, flexible silicone foam. The bandwidth at X-band is greater than 1.11:1 at the 20db level. B. F. Goodrich Co., Shelton, Conn.

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Digital Logic Modules

Data is available on a new line of silicon, digital logic modules designated Series 1039. The modules are potted in an epoxy for reliability and to avoid dip soldering hot spots. The series, designed for optimum noise immunity and worst-case tolerance conditions, includes bistables, inverters, a driver and a gate. All modules can be integrated for multiple logic functions. Any output may be shorted to ground without damage to any component. Ess Gee Inc., 1 Holland Ave., White Plains, N. Y.

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System Scanners

This 19-page catalog contains photos and specs. for a complete line of system scanners. The units are used for the sequential transfer of data between signal or load for measurement, recording, control, computation, and communication. Teradyne Inc., 87 Summer St., Boston, Mass.

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Microwave Catalog

This short-form catalog, No. 13, describes microwave and UHF instruments. The catalog is divided into 7 sections covering such topics as antennas, tuners, waveguides, attenuators, bolometers, couplers, freq. meters and VSWR devices. Narda Microwave Corp., Plainview, L. I., N. Y.

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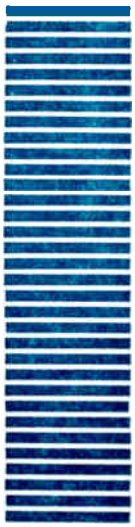

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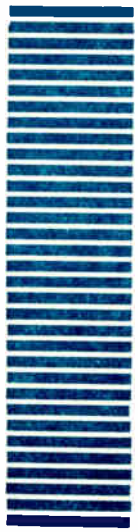

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NEW TECH DATA

R-F Power Transistor

The RCA 40279 is an ultra-high reliability version of the RCA 2N3375 Overlay power transistor. The device is an epitaxial silicon n-p-n planar transistor intended for Class A, B or C amplifier, freq. multiplier, or oscillator operation. It should find broad uses in transmitters requiring up to 7.5w of output power at 100MC and 3.0w. @ 400MC. More data available from RCA Electronic Components & Devices, Harrison, N.J.

Circle 151 on Inquiry Card

Antenna Selector

This selector guide enables the engineer to (1) calculate the optimum take-off angles for skywave transmission between any two stations, and (2) identify the antenna which radiates at these angles. The guide consists of a skywave transmission chart on which the engineer plots the desired radiation pattern, and a group of transparencies on which antenna radiation patterns are drawn. To find the antenna which radiates the desired pattern, superimpose these transparencies over the pattern. Granger Associates, 1601 California Ave., Palo Alto, Calif.

Circle 152 on Inquiry Card

Design Ideas

"Practical Design Ideas Using Taylor Materials," a 20-page, 2-color booklet is available. It illustrates and describes how laminated plastic, filament winding and vulcanized fibre can cut costs, reduce weight, save production time and improve performance. Twenty-nine illustrations are given. Taylor Corp., Valley Forge, Pa.

Circle 153 on Inquiry Card

Test Reports

Six reports discussing properties and testing of magnesium oxide (MgO) are now available. These reports are the first in a long series entitled "Engineering with Magnesium Oxide." The first 6, ranging from 2 to 4 pages, deal with impedance; thermal conductivity; magnetics; iron content; sintering; and sampling and reduction to test weight. General Electric Co., Chemical Materials Dept., Pittsfield, Mass.

Circle 154 on Inquiry Card

Germanium Power Transistor

The DTB-110B germanium power transistor is designed for high-quality, low-cost home entertainment uses. The device reduces to 2 the number of output transistors needed for Class A, B audio circuits in the 100w. 8Ω load class. It performs in 65w. amplifiers with a freq. response of 0.1db from 10 to 20K CPS, less than 0.4% intermodulation distortion, and less than 0.25% total harmonic distortion over the full power range. Complete details available from Delco Radio, div of General Motors Corp., Kokomo, Inc.

Circle 155 on Inquiry Card

NEW TECH DATA

Integrated Choppers

Data is available on 14 different types of integrated choppers. They have emitter breakdown voltages to 50v., and offset voltages to 25μv. Three series of integrated choppers are available: the general-purpose 3N105-107, the 3N90-95, and the 3N100-104. All are available off the shelf. Crystalonics, Inc., 147 Sherman St., Cambridge 40, Mass.

Circle 156 on Inquiry Card

Square Trimming Potentiometers

A short-form catalog describing standard and special models of micro-miniature trimmers is available. Includes humidity-proof and commercial versions of 3/8 and 1/4 in. sq. sizes. Presents mechanical, electrical and environmental characteristics. Techno-Components Corp., 7803 Lemona Ave., Van Nuys, Calif.

Circle 157 on Inquiry Card

Coaxial Pulse Magnetron

The all metal-ceramic L-3958 tube is a 10 kw, Ku-band coaxial magnetron. Operating freq. is fixed at 15,000 ($\pm$85) MC. Designed initially for weather avoidance radar systems, it should find use in many types of airborne or lightweight radar systems such as fire control, terrain following and navigation systems. More data available from Litton Industries, Electron Tube Div., 960 Industrial Rd., San Carlos, Calif.

Circle 158 on Inquiry Card

Automatic Solderer

This new catalog describes three modular systems of wave soldering equipment using exclusive oil/solder mix. Also shown are examples and photographs of types of parts soldered on the equipment. Hollis Engineering, Inc., Pine St. Extension, Nashua, N. H.

Circle 159 on Inquiry Card

DVM Brochure

This 12-page brochure describes Model 4000, high impedance, integrating 4-digit digital voltmeter. This brochure describes 17 features of the instrument, its operating principles, specs., and DVM accessories including ac converters and ohmmeters. Hughes Instruments, 2020 Oceanside Blvd., Oceanside, Calif.

Circle 160 on Inquiry Card

Miniature Connectors

Data is available on a line of miniature connectors compatible with existing Mil-C-22557A types. They fit 0.141 in. dia. semi-rigid coax. They are only 0.077 larger than the cable itself. The small back nut allows positive soldering to the outer sheath of the cable without the high heat requirements of larger connectors. Micon Electronics, Inc., Roosevelt Field, Garden City, L.I., N.Y.

Circle 161 on Inquiry Card

NEW TECH DATA

Microwave Power Source

The WJ-282 is a 1kw 35.5 Gc oscillator. It is an "O" type tube using a coupled cavity circuit. It operates as a forward-wave oscillator near the center of the circuit passband. Beam efficiencies of 13.5 to 16.7% have been obtained. The device is a low cost power source because only one tube need be used, as compared to the usual amplifier chain. More data available from Watkins-Johnson Co., 3333 Hillview Ave., Palo Alto, Calif.

Circle 162 on Inquiry Card

Antennas & Microwave Devices

This catalog entitled, "Antennas & Microwave Devices," describes filters and multiplexers, pedestals, test equipment, etc. for microwave uses. Each item is pictured and complemented with complete specs., including graphs. Dorne and Margolin, Inc., 29 New York Ave., Westbury, N.Y.

Circle 163 on Inquiry Card

Precision Potentiometers

Data sheet 65481 describes the Model 7246 potentiometer, a low cost 10-turn unit. The ⅞ in. dia. pot has standard resistances from 10Ω to 50KΩ. It has a molded plastic housing, gold-plated terminals, and ¼ in. dia. stainless steel shaft. Photograph, drawing, and complete electrical and mechanical specs. are given. Helipot Div., Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif.

Circle 164 on Inquiry Card

Ceramic Coatings

Data is available on 2 ceramic coatings which extend design freedom to micro-circuit engineers. The compounds facilitate crossovers of conductive lines by using escalated firing cycles. Electro-Science Laboratories, Inc., 1133-35 Arch St., Philadelphia, Pa.

Circle 165 on Inquiry Card

Power Modules/Supplies

Catalog No. 651, 50 pages, describes a line of power supplies, power modules, inverters, rack mounts, and thermal radiators. The data includes photos, line drawings, curves, and complete operating specs. Technipower, A Benrus subs., 18 Marshall St., Norwalk, Conn.

Circle 166 on Inquiry Card

Channel Carrier System

Data is available on a 125Kc channel bandwidth carrier system. It is designed for telemetry, facsimile and data transmission uses. The system provides 14 channels on a single 8Mc baseband, and features low intermodulation distortion, solid state modular construction and an output of 10v. p-p. The number of channels transmitted varies with the amount of baseband available. Jerrold Electronics Corp., 15th & Lehigh Ave., Phila., Pa.

Circle 167 on Inquiry Card

NEW TECH DATA

Antenna/Systems

This 20-page catalog pictures and describes a line of antennas for commercial, industrial, and military uses. Complete operating specs. and gain pattern configurations are included. In addition, data is included for coaxial cable, adapters, couplings, and end seals. Mosley Electronics, Inc., 4610 N. Lindbergh Blvd., Bridgeton, Mo.

Circle 168 on Inquiry Card

Lamp Catalog

The lamps described in this 16-page catalog emphasize micromodules and completed microminiature assemblies. Most significant is a microminiature multifilament lamp. An array of filaments within a single lamp can be lighted collectively or individually as specific needs demand. Pinlite Div., Kay Electric Co., 1275 Bloomfield Ave., Fairfield, N.J.

Circle 169 on Inquiry Card

Delay Line

Bulletin SDL-1 describes a 500nsec. delay unit. It includes full specs. and suggested uses. Phelps Dodge Electronic Products Corp., P. O. Box 187, 60 Dodge Ave., North Haven, Conn.

Circle 170 on Inquiry Card

Facility Brochure

Brochure No. BA-162, "This is Sonotone," is a product facility brochure on the history and capability of rechargeable nickel-cadmium batteries. The brochure describes product applications, design and development, and battery capability and packaging. Battery Div., Sonotone Corp., Elmsford, N.Y.

Circle 171 on Inquiry Card

Analog Division Modules

Analog division modules which do away with high-gain operational amplifiers and logarithmic circuits are described in Bulletin MM110. A combination of magnetic and semiconductor circuits results in analog division with absolute accuracies of 1%. Freq. range is 60 cps to 100kc. General Magnetics Inc., 135 Bloomfield Ave., Bloomfield, N. J.

Circle 172 on Inquiry Card

Conductive Adhesive

Helix Bonding Agent R-321 is a silver-filled, 2-part, fast setting adhesive. It has an initial volume resistivity of 0.005Ω-cm when cured 24 hrs. at 77°F. When post cured for 1 hr. at 150°F, the volume resistivity drops to 0.002Ω-cm. This value remains the same through 200°F. It is recommended for use as a repair adhesive for PC, h-f shielding, and the assembling of wave guides. More details available from Carl H. Biggs Co., Inc., 1547 14th St., Santa Monica, Calif.

Circle 173 on Inquiry Card

Pushbutton Bulletin

Bulletin 50-P1 describes a complete line of oil tight pilot controls. Covered are pushbuttons, push-pull operators, pilot lights, push-to-test lights, illuminated pushbuttons, various selector switches, contact blocks, accessories, and control stations. The colorful 8-page bulletin provides data on construction features, ratings, and typical schematic diagrams. Furnas Electric Co., Batavia, Ill.

Circle 174 on Inquiry Card

Pot Cores

Bulletin 220 contains data on the complete line of precision pot cores for practically every inductor use. There are also 9 pages of technical design information covering every inductor requirement. Ferroxcube Corp. of America, Saugerties, N. Y.

Circle 175 on Inquiry Card

Recorders Catalog

A line of recording instruments are listed in the 2-color, 20-page Series A catalog. It includes specs. for: electrodynamometer, permanent-magnet moving-coil, inkless and ink event, pressure and vacuum, and position and motion. Also included is a measurement table which shows the range of measurements possible with this line of recorders. Esterline Angus Instrument Co., Inc., P. O. Box 24000, Indianapolis, Ind.

Circle 176 on Inquiry Card

Control Knobs

This series of ½ in. dia. knobs meets or exceeds the performance spec. of Mil-K-3926A. Series 5 knobs are supplied with two 4-40 Class 3A socket head, cup point, steel set screws. The knobs are designed for ⅛ in. shafts. Aluminum insert has been treated to resist corrosion. More data available from National Radio Co., Inc., 37 Washington St., Melrose, Mass.

Circle 177 on Inquiry Card

Counters Bulletin

Bulletin No. 341 will assist engineers in specifying printing impulse counters for all types of uses. It contains complete specs., operating characteristics, dimensions, and typical installation diagrams. The counters described have both visual readout and printout. Landis & Gyr, Inc., 45 W. 45th St., New York, N. Y.

Circle 178 on Inquiry Card

Explosion-Proof Housings

Bulletin 165, 36 pages, covers over 240 sizes of UL-listed explosion-proof and weather-proof housings and boxes, control stations, operators, and fittings. Each item is illustrated with photograph and dimensional drawing. Complete inside and outside dimensions are shown, so that housings can be detailed directly from the catalog. Adalet Mfg. Co., 4803 W. 150th St., Cleveland, Ohio.

Circle 179 on Inquiry Card

Plug Guide

Numerous lines of multicontact electrical connectors are described in Catalog PG-7. The publication provides data concerning each connector series, indicating relationships and differences between the series. The guide also lists the catalogs available which contain detailed data on specific connector series. ITT Cannon Electric, 3208 Humboldt St., Los Angeles, Calif.

Circle 180 on Inquiry Card

Coating Facts

"Coating Facts" is a technical data sheet on "Conformal Coatings." The bulletin is directed at engineers who are concerned with the protection of printed circuits, electronic components, semiconductor devices, and similar products. Zicon Corp., 63 E. Sandford Blvd., Mt. Vernon, N. Y.

Circle 181 on Inquiry Card

Miniature Readout

The series 340 microminiature rear-projection readout is ½ x ¾ x 2 in. It can project up to 11 different messages on its front viewing screen, with a max. character height of ⅜ in. It displays anything that is photographically reproducible, such as numbers, letters, words, multi-words, symbols, special characters and colors. More data available from Industrial Electronic Engineers, Inc., 7720 Lemona Ave., Van Nuys, Calif.

Circle 182 on Inquiry Card

Calibration Baths

Data is available on baths that may be used for calibrating transducers, thermometers, filled system temp. instruments or other uses where a temp. controlled bath is needed. Working ranges vary from —100°F to 1300°F. Hallikainen Instruments, 750 National Court, Richmond, Calif.

Circle 183 on Inquiry Card

Coil Winder

A data sheet is available describing a coil winder which winds both layer and universal (cross) coils. The Model BGO-2 provides linear and non-linear layer winding, plus cross winding, with the same winding head. Associated American Winding Machinery, Inc., 750 St. Ann's Ave., Bronx, N. Y.

Circle 184 on Inquiry Card

High-Purity Metal

A brochure describing ultra-high-purity metal and alloy products and services is available. Products include ultra-pure metals and alloys, single crystals, spectrographic standards, sputtering electrodes and metals for evaporation. Services listed are custom alloying, fabrication and an X-ray diffraction service laboratory which obtains X-ray diffraction patterns from 4.2°K to 3000°K. Materials Research Corp., Advanced Materials Div., Orangeburg, N. Y.

Circle 185 on Inquiry Card

NEW TECH DATA

Pots & Dials Catalog

This short form catalog covers Micropot® precision and trimming potentiometers and Microdial® counting dials. It contains master charts of pots and trimmers. It also includes photos and data on each model. Actual size photos illustrate 6 types of Microdials. Amphenol Controls Div., Amphenol-Borg, 120 S. Main St., Janesville, Wisc.

Circle 186 on Inquiry Card

Card Reader

Data is available on a compact, 50-contact card reader. The Model 50 is used where panel space and dependability are of prime importance. It uses a wallet-size, vinyl programming card. Each of the 50 contacts, or switches, has a current-carrying capacity of 10a. and nominal contact-to-pin resistance of 0.0025Ω. This is accomplished by a patented 360° dual wiping action on each contact pin. Insertion of the program card automatically actuates the desired circuits. The Hickok Electrical Instrument Co., Switch Div., Dept. SW-80, 10514 Dupont Ave., Cleveland, Ohio.

Circle 187 on Inquiry Card

Broadcast Tubes

A new fact sheet, "Penta Broadcast Tubes," describes 9 power tubes, ranging from 65w. to 1kw plate dissipation. They are presently used in AM, FM and TV broadcast transmitters. Also included is data on beam pentodes suitable for use in the design of new broadcast equipment. Penta Laboratories, Inc., 312 N. Nopal St., Santa Barbara, Calif.

Circle 188 on Inquiry Card

Digital Printer

Data is available on a digital printer that uses a 6-font print drum to provide for mechanically changing from one 4-line binary code to another. To change the input character code, the print drum is simply indexed so that the desired font vs. character code coincides with a keyway on the print-drum shaft. Thus, circuit changes are not required to change coding. Franklin Electronics, Inc., Bridgeport, Pa.

Circle 189 on Inquiry Card

Microwave Attenuators

This data sheet describes the 1904 Ultra-Precision 30MC Cut-off Attenuators. This unit was based on a design submitted by the National Bureau of Standards. Also described is the PRD 1903, a high precision attenuator. This unit is useful for many special applications where an attenuator reference standard is required. Design features and performance data are described for both units, including freq. range, accuracy, digital readout, attenuation range, etc. PRD Electronics, Inc., subs. of Harris-Intertype Corp., 202 Tillary St., Bklyn., N. Y.

Circle 190 on Inquiry Card

Test Equipment

Catalog M-4 describes "Off-The-Shelf" environmental test equipment. It contains a multitude of equipment, photographs, specs., and prices. Environmental simulation equipment includes standard temp., humidity, salt spray, and altitude chambers, within a size range of ½ through 27 cu. ft. of work space. In addition, shock machines, vibration slip tables and a host of valuable accessories are also described. Associated Laboratories, Inc., 200 Rte. 46, Wayne, N. J.

Circle 191 on Inquiry Card

Digital Circuits

The series 10A open and 10B potted digital modules are logic elements for use in decisional logic (control) systems or arithmetic logic (data handling) systems, including peripheral equipment circuits. They are intended for low to medium speed uses up to 10KC. Designed life is 20 yrs. minimum. Amb. temp. range is −10°C to +70°C. More data available from Standard Telephone & Cables Ltd., Connaught House, 63, Aldwych, London, W.C. 2, London.

Circle 192 on Inquiry Card

Capabilities Catalog

Bulletin 1322 is a 24-page general catalog describing transducer products and capabilities. Described are pressure and vibration transducers, strain-gage and piezoelectric accelerometers, airborne vibration monitoring systems, galvanometers, pressure standards, electromanometers, miniature differential dc amplifiers, and Ceramicite hermetic seals. Consolidated Electrodynamics Corp., subs. of Bell & Howell, 360 Sierra Madre Villa, Pasadena, Calif.

Circle 193 on Inquiry Card

Silicone Die Lubricant

Data is available on a newly-developed silicone die lubricant. It offers the possibility of selecting one universal die lubricant for both aluminum and zinc. The material is available in solvent solution, emulsion, and grease compound forms. It gives the high performance benefits of silicones, providing excellent release and lubricity without interfering with subsequent painting or plating of cast parts. General Electric Co., Silicone Products Dept., Waterford, N. Y.

Circle 194 on Inquiry Card

Anechoic Chambers

A brochure is available which features shielded chambers with special aspects such as 6 x 15 ft. shielded double door. Chambers are functional to 100MC, and exceptionally quiet at X-band. All units, tested by the pattern comparison method, showed internal reflectivity of 44 to 49db down at L-band. Shielding insertion loss exceeded requirements of 60, 100 and 80db respectively, for magnetic and electric fields, and plane waves. Emerson & Cuming, Inc., Canton, Mass.

Circle 195 on Inquiry Card

Core Memories

Data on 3 coincident current, core memory systems are available. The Model CC100 has read/write cycle time of 1μsec.; word size to 16,384 words and bit length of 4 to 60 bits; Model CC200 has read/write cycle time of 2μsec., and the same word size and bit length as the CC100. Model CC500 has read/write cycle time of 4.8 to 10μsec., word size to 16,384 words, and bit length 4 to 36 bits. These systems are available for commercial use or to military spec. Lockheed Electronics Co., Avionics and Industrial Products Div., 6201 E. Randolph St., Los Angeles, Calif.

Circle 196 on Inquiry Card

Logic System

The DES-30 is a low-cost, general-purpose digital logic system that adds hybrid capabilities to small analog computers. It may be linked to any general-purpose analog or digital computer, or may be used autonomously as an aid to digital instruction or design. Operations can be as slow as 1 cps. Complete details available from Electronic Associates, Inc., Long Branch, N.J.

Circle 197 on Inquiry Card

Compound Selection Manual

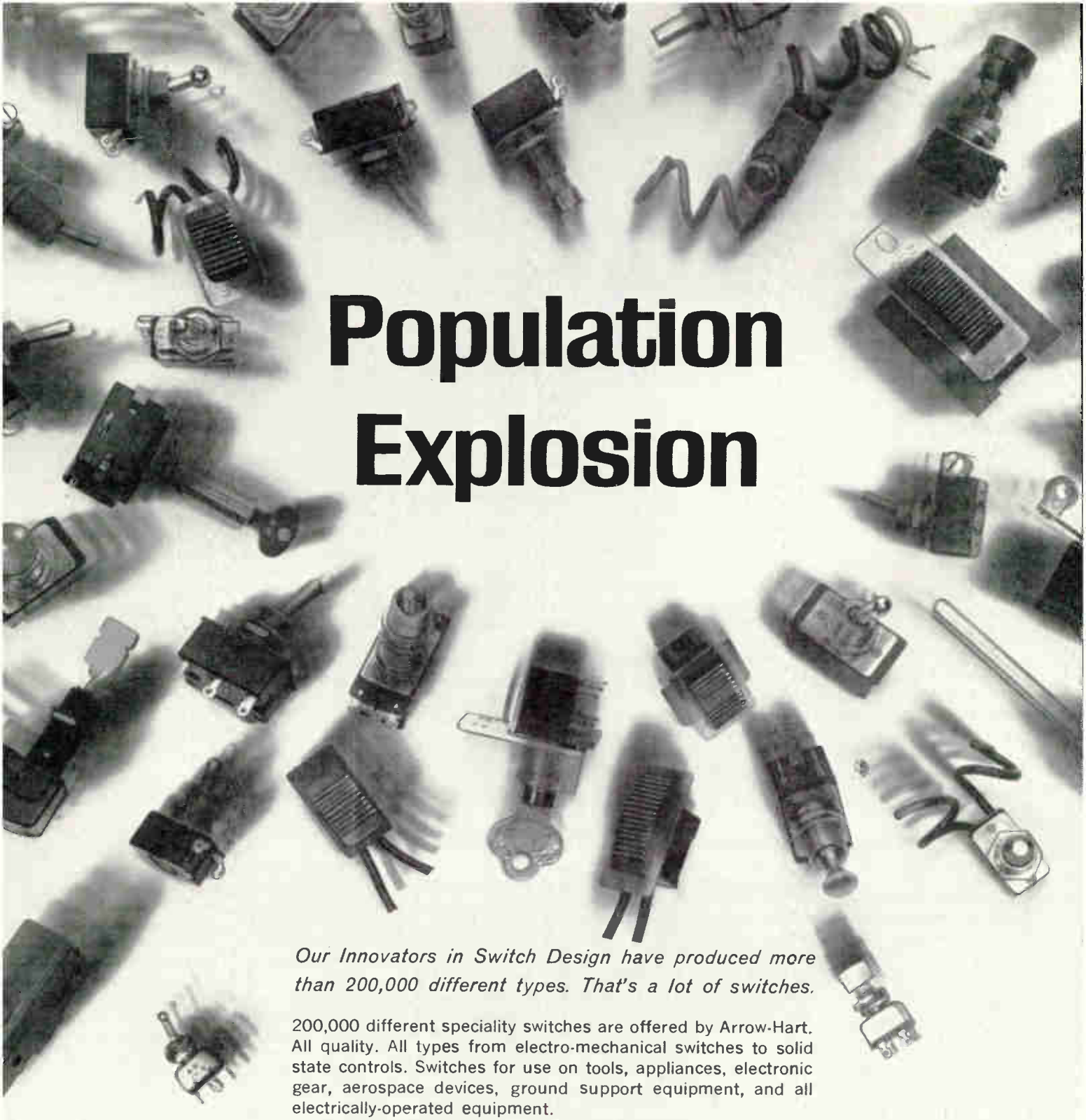
This 110-page O-Ring and seal compound manual not only simplifies determination of seal elastomers, but is a complete work, covering essential data needed for compound selection. It covers general engineering and chemical data on basic elastomers both common and exotic usage types. Sections on physical characteristics, test and spec. data, special application data, and many explanatory charts and tables are included. Parker Seal Co., 10567 Jefferson Blvd., Culver City, Calif.

Circle 198 on Inquiry Card

Ignitron Substitute

Data is available on a 1K ampere RMS solid-state substitute for the type B Ignitron. For use with single-phase, 460v., 60 cycle ac power sources, the semiconductor-based module will operate at 25 cycles (max.) on and 2 sec. (min.) off. Especially applicable to resistance welders, the new module, when suitable semiconductors are included, makes it possible to include the welder and transformer in a single compact unit. International Rectifier Corp., 233 Kansas St., El Segundo, Calif.

Circle 199 on Inquiry Card



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DIAGNOSES REDUNDANCY IN DATA

The problem of diagnosing data redundancy appears to be solved by the Data Management Analyzer, a product of Radiation, Inc. It performs the functions of 2 computers, analyzing single channel analog or digital data at rates to 10KC. The system determines the amount of redundancy, data order, and interpolation error due to original sampling.

"Eleven Proposed Test Methods for Plastics Parts in Household Appliances" is the title of a book prepared by the Appliances Committee of The Society of the Plastics Industry, Inc., 250 Park Ave., New York, N.Y. These test methods are intended to help users and fabricators determine the quality and uniformity of molded, extruded and other fabricated components used in this field. Copies are available at $2.00 each.

The National Bureau of Standards, Washington, D.C., has made available copies of MIL-STD-793-1 (WP), which covers definitions, letter symbols, color code, and circuit symbols for Hall Effect Devices. The 28-page standard also contains a tutorial appendix.

A technical report by the Naval Ordnance Laboratory on the test and evaluation of the Davers Series A-10 Photovoltaic Indium Antimonide Infrared Detector is available from Davers Corp., Horsham, Pa. The data covers noise spectrum, detectivity, sensitivity, time constant, and spectral response.

Locating failures in overhead power transmission lines now requires visual inspection. This chore has been simplified by a line fault locator developed by Tokyo Shibaura Electric Co., Ltd. The locator, which remains in the power station, works on a radar principle. A sharp locating pulse is sent along the line until it reaches the fault. Then it is reflected back to the station where its travel time is converted into distance. This way the exact location of the fault is found.

A simple method of quickly and easily calibrating oscilloscopes, altimeters, and radar systems is provided by a 500nsec. delay line. The unit, by Phelps Dodge, New Haven, Conn., has a tolerance of ±0.25nsec. It fits conventional rack mounting.

Magnetic Testing—Theory and Nomenclature—STP 371 presents in a simple and understandable manner the theory and nomenclature basic to work in the magnetic materials arts. The manual gives alternate procedures which have proved useful in obtaining routine data. The book also covers a variety of techniques for securing important special purpose magnetic data. It is available from American Society for Testing and Materials, Phila., Pa. for $2.50.

The NBS has compiled two lists of symbols that will constitute the Bureau's standard editorial practice for use in all its publications. One list contains Electrical Engineering Symbols and Units, and the other is a list of important physical constants. Both lists are available from the National Bureau of Standards, Washington, D.C.

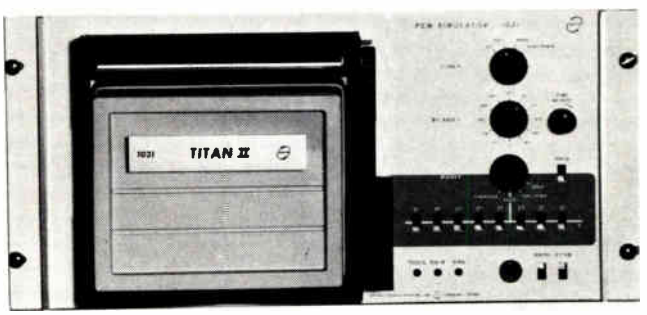
The National Research Council of Canada and the NBS Inst. for Basic Standards have completed a comparison of inductive voltage divider calibrations. This insures a uniform basis for voltage-ratio measurements in the two countries. The tests, which were performed on the same divider, showed agreement of voltage-ratio and phase-angle to within 1 part in 10 million of input at 400 cps and 1 kc.

Volumes of a few cubic microns can be quantitatively analyzed to accuracies of about 1% with the Model MS-64 electron probe X-ray microanalyzer. The electron probe, sold by Acton Laboratories, Acton, Mass., may be used for research and analysis in metals, ceramics, minerals, semiconductor materials and biological specimens.

An automatic instrument that detects, measures and records even the minutest insoluble impurities in liquids has been developed by the Graver Water Conditioning Co., New York, N.Y. Called the Automatic Tape Analyzer, it is so sensitive that it can note the presence of two solid particles in a billion parts of water.

PCM SIMULATOR PERMITS DYNAMIC TESTS

Static and dynamic exercising of PCM systems is one function of a new versatile patch-programmed PCM Simulator. In addition, Model 1031 can generate an unusually diverse and quickly interchangeable selection of formats, including Saturn, Apollo, Gemini, Advent, Polaris, and others. The system, a product of Data-Control Systems, Inc., Danbury, Conn., generates a serial PCM wavetrain to which may be added noise and jitter to simulate signals from receivers or magnetic recorders.



By RENE GOLDBERGER,
Group Leader
Research and Development
Daystrom Ltd.
Division of Weston Instruments, Inc.
Cooksville, Ontario, Canada

Thermal Probe

THE COMMON METHOD OF EVALUATING the performance and reliability of an electronic prototype has been to insert the complete breadboard into a calibrated temperature chamber. Power and monitoring leads are passed through the chamber to provide input signals and output metering information. The test circuit inside the test chamber is temperature cycled, and the output signals are monitored on test instruments. If a component fails during temperature cycling for any reason whatsoever, the temperature chamber must be returned to ambient before opening to prevent condensation from forming inside. All this is time-consuming. There is also sometimes the inconvenience of having to tie up significant test instruments at the test chamber remote from the engineer's bench.

To overcome the problems just described, a thermal probe has been developed that brings the temperature chamber to the developmental breadboard. Most significant advantage is the ability to temperature cycle a single component at a time and to measure its effect on a number of overall performance characteristics.

How the Thermal Probe Operates

The thermal probe unit, Fig. 1, uses two thermoelec-

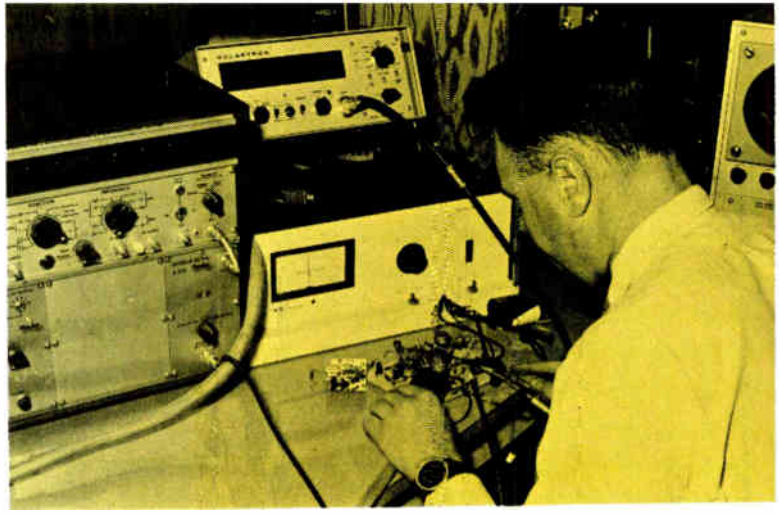


Fig. 3: The "Thermoprobe" in use for breadboard testing.

Convenient substitute for the usual temperature chamber in environmental testing of circuit components saves time and expense.

Speeds Environmental Testing

tric elements in the tip assembly to pump heat to the component under test. Controls are provided to permit the component under test to be lowered to −15°C or raised to as high as +75°C at a room ambient of 25°C. The temperature at the tip of the probe is monitored by a copper-constantin thermocouple connected to a pyromillivoltmeter.

The theory of operation of the complete instrument is shown in the block diagram of Fig. 2. The instrument is based on a Canadian development originated by D. Makow at the National Research Council. When used for cooling, heat is extracted from the electronic component under test in the tip assembly and transferred by thermal conduction to thermoelectric elements. The elements are energized by a low-voltage, high-current dc power supply (up to 15 a. for cooling at 2.8 v. dc) at a ripple contest of less than 5%. This current pumps the heat extracted from the component under test to opposite faces of thermoelectric elements exposed to cooling liquid. The cooling water, or water and ethylene glycol solution, is circulated through a heat exchanger where the heat is transferred to the room ambient.

In the heating mode, up to 4.5 a. are sent through the thermoelectric elements in the opposite direction. Heat is then pumped from ambient to the electronic component clamped in the tip assembly as a function of the dc current selected by the control knob.

A general view of the thermal probe, as used on a design bench, is shown in Fig. 3. Three sizes of probes as provided with the production unit, and an inexpensive copper bar can be used by the circuit designer to form a particular probe configuration.

"Thermoprobe" Specifications

The "thermoprobe" developed by Weston, their Model 1574, has a temperature range of −15°C to +75°C (in 25°C ambient). Its response time is about 2 minutes to reach 0.632 of set temperature. Power consumption is 200 w. max. at 110 v. ac, 60 cps. The temperature indicator is a pyromillivoltmeter scaled −60°C to 100°C. Cooling capacity is 0.5 pint (260 cu. cm) of water.

Bibliography

(1) Cadoff, I. B., *Thermoelectric Materials and Devices*, Reinhold Publishing Corp., New York, N. Y., 1960.

(2) Keane, J., *Understanding and Using Frigistors*, Needco Frigistors Ltd., Montreal, Canada.

(3) Makow, D. M., *Portable Thermoelectric Pump*, NRC, Ottawa, Canada.

Fig. 1 (left): A portable thermoelectric instrument which produces temperature variations on individual in-circuit components. Unit consists of two solid state thermoelectric elements whose actions depend upon the Peltier Effect of absorption or generation of heat at the junction of dissimilar metals through which an electric current is passed.

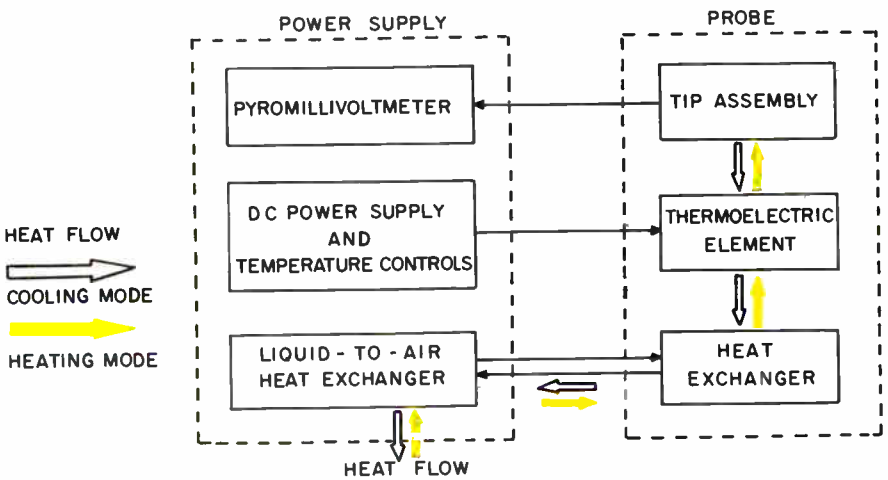


Fig. 2 (right): How the thermal probe works.

EDITOR'S NOTEBOOK

ELECTRONIC BLOODHOUND developed by Honeywell detects concentrations of toxic perchlorethylene vapor at levels as low as 10/1,000,000. Called Per-tector, the unit safeguards cleaning and degreasing areas. The device pulls air between two ultraviolet units. Sensor detects vapor and activates warning light or a fan.

DO-IT-YOURSELF computer service, called Data-Mat, just opened in Chicago. It allows customers to drive in with unprocessed data much as a housewife goes to a laundromat. Customers have free parking and use of private offices to sort out data while waiting turns on any of four Honeywell computer systems. The midtown center is open around-the-clock, all week. Attendants are available at all times.

COMPUTERS AND TV are causing "realistic auto accidents" to find preventive measures. U.S. Public Health Service and Goodyear Aerospace Corp. are using a test model simulator developed by Goodyear with TV to scan realistic terrain model. Image is projected on a high-gain spherical projection screen in front of driver in real but stationary auto. Researcher causes accidents with buttons and analog computer records and evaluates driver's reaction.

HIGH-FIDELTY balancing in home mono or stereo speaker systems can now be done by anyone by just following directions from a 45 RPM record. Presented by KSC Systems, Inc., New York, the record makes it possible for the home listener to adjust speaker controls by ear, in just five minutes, according to KSC. Each speaker system, then, is individually "tuned" to conform with the room acoustics and associated phono equipment.

PUSH-BUTTON system for paying bills, billing and banking by telephone is being introduced by AT&T. Heart of the system is a new "touch-tone" push button telephone that transmits musical tones, rather than dial pulses, to operate switching equipment. Tone signals will allow telephones to communicate with computers. Uses will include sending billing data, retail accounting, and receiving "voiced" data from computer-simulators.

'IDLE' RADIO SETS recently gave the FCC a go-around when an industrial radio station in Massachusetts complained of interference by a construction company. Boston investigators found that the construction company was defunct and a finance firm had repossessed the company's radio-equipped trucks, which were parked in a fenced lot. The still radios proved too much of a magnet for local children who climbed in and literally went on the air. On strong suggestion, the finance company removed the radios.

VOTE COUNTING machines and hand counters vied with each other recently to confirm results of a close race in San Diego's general election. The recount of some 110,000 votes was done by Cubic Corp.'s Votronics machines to declare the winner over the incumbent for a county supervisor post. Count between machine and hand was only five votes off. The incumbent official was assessed $1,377 for the hand count. The challenger was assessed only $691 for the machine count.

STUTTERING COMPUTERS have won a degree for a Purdue graduate student. Dr. Blaine Butler, now a major at the Air Force Academy, postulated a simplified model of human speech system, from study of psychological and biological data on how stuttering is made worse, or improved. He found that measures which increase or reduce stuttering, when simulated by electronic impulses, produce comparable behavior in the computer.

HIGHWAY SAFETY computer system has been established by Illinois Department of Public Safety to help reduce highway deaths and traffic violations. The system, an IBM 1401, reports Gov. Otto Kerner, will be refined so that data will be available on all violations, violators and accidents for any 7-mile stretch of highway in the state. It will assist in crime control, as well as handle traffic tickets, accident reporting, and activity reporting from state troopers.

SONOBUOYS gave Philadelphia FCC engineers some interference trouble. The FCC men, tracking down interference to National Guard aircraft frequencies, found that they were looking for Naval underwater detection gear. They found the trouble in the Sonobuoys (dropped from aircraft to detect submarines). The offending equipment was being operated on land by a Naval Reserve electronics training unit; its commanding officer had a new problem for students to resolve.

BOOKS

Engineering Systems Analysis

By A. G. J. MacFarlane. Published 1965 by Addison-Wesley Publishing Co., Inc., Reading, Mass. Price $8.50. 272 pages.

Book presents a unified approach to dynamical system theory and those recent developments that make use of the theory of linear vector spaces. Analysis methods are developed from first principles and make much use of the concepts of circuit theory. This facilitates the unified treatment of mechanical dynamical systems, electrical circuits, electromechanical systems, and feedback control systems.

Control System Design

By Stanley M. Shinners. Published 1964 by John Wiley & Sons, Inc., 605 Third Ave., New York, N. Y. 10016. Price $11.75. 523 pages.

Book is a unified presentation of linear, nonlinear, stochastic, sampled-data optimal, and adaptive control system design. It ranges from a discussion of such classical methods as Nyquist and Bode diagrams to modern concepts such as Liapunov's stability criterion, state-space variables, dynamic optimization, Pontryagin's Maximum Principle, and Kalman filtering. Also, recognition of the importance of computers in control system design is particularly significant.

Dictionary of Data Processing

Compiled by L. Trollhann and A. Wittmann. Published 1965 by American Elsevier Publishing Co., Inc., 52 Vanderbilt Ave., N. Y. 17, N. Y. Price $17.00. 300 pages.

This dictionary contains about 5,000 entries in English/American, German and French relating to: digital and analog computers and their most important components; mathematical terms in constant use; office automation and organization relative to commercial data processing; technical and scientific uses of computers; and civil and military data transmission terms.

Electrical Engineering

By Julius I. Franklin, P.E. Published 1964 by The Macmillan Co., 60 Fifth Ave., New York 11, N. Y. Price $9.00. 387 pages.

This is one of a series of six books covering topics given in the state licensing examinations for professional engineering certification. It is an outgrowth of the course materials used by the author in P.E.'s license examination review courses.

Mr. Franklin attempts to sharpen the candidate's problem-solving ability. He provides theory as well as derived equations. He also discusses the application of theory to sample problems selected from past examinations. The book also serves as a refresher and reference for engineering graduates.

Manual of Electromechanical Devices: Component Types, Characteristics, Design Applications

By Douglas C. Greenwood. Published 1965 by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 10036. Price $12.50. 327 pages.

Provides all the information needed to choose and design the best device for a particular product or system. Over 100 specific types are discussed and analyzed. Each individual component's composition, properties, performance - application tendencies, and reaction to varying forms of treatment are discussed. Also, advice on finishes and assembly procedure is offered. Many design aids are included.

Analysis and Synthesis of Linear Time-Variable Systems

By Allen R. Stubberud. Published 1964 by University of California Press, Berkeley and Los Angeles, Calif. Price $4.75. 108 pages.

This book treats the problems of analyzing and synthesizing physical systems which can be described by finite-order linear time-variable differential equations. Although problems in both analysis and synthesis are discussed, the book focuses on synthesis, and especially on the synthesis of feedback systems.

Listen to Leaders in Science

Edited by Albert Love & James Saxon Childers. Published 1965 by Tupper and Love, Inc., Atlanta, and David McKay Co., Inc., 750 Third Ave., New York, N.Y. 10017. Price $5.50. 278 pages.

Book is comprised of original pieces by some outstanding men in science, writing on the aspects of their profession that they know best. Each contributor has written, in non-technical language, on the excitement and challenge of his field.

Books Received

Handbook of Electron Tube and Vacuum Techniques

By Fred Rosebury. Published 1965 by Addison-Wesley Publishing Co., Inc., Reading, Mass. Price $17.50. 597 pages.

Mandl's Television Servicing, 3rd Ed.-Newly Revised

By Matthew Mandl. Published 1965 by The Macmillan Co., 60 Fifth Ave., New York 11, N. Y. Price $8.95. 441 pages.

Microwave Measurements Manual

By Robert Kellejian and Clifford L. Jones. Published 1965 by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 10036. Price $4.50. 152 pages, paperback.

Theory of Sampled-Data Control Systems

By David P. Lindorff. Published 1965 by John Wiley & Sons, Inc., 605 Third Ave., New York, N. Y. 10016. Price $10.75. 305 pages.

An Introduction to Patents for Inventors and Engineers (formerly titled: Patent Notes for Engineers)

By C. D. Tuska. Published 1965 by Dover Publications, Inc., 180 Varick St., New York 14, N. Y. Price $1.50. 192 pages, paperback.

Single Sideband Handbook

By William P. Henneberry. Published 1964 by The Technical Materiel Corp., 700 Fenimore Rd., Mamaroneck, N. Y. Price $10.00. 210 pages.

(Continued on Page 20)

Planning & Preparing Data-Flow Diagrams

By J. J. DiCerto. Published 1964 by Hayden Book Co., Inc., a division of Hayden Publishing Co., Inc., 850 Third Ave., New York 22, N. Y. Price $10.50. 90 pages.

Servomechanism Fundamentals and Experiments

By Members of the Staff, Philco Technological Center. Published 1964 by Prentice-Hall, Inc., Englewood Cliffs, N. J. Price $10.60. 248 pages.

Radio and Television Receiver Circuitry and Operation, Revised Edition

By A. A. Ghirardi and J. E. Dines. Published 1964 by Holt, Rinehart and Winston, Inc., 383 Madison Ave., New York, N.Y. 10017. Price $10.00. 556 pages.

Linear Electric Circuits

By Wallace L. Cassell. Published 1964 by John Wiley & Sons, Inc., 605 Third Ave., New York, N. Y. 10016. Price $10.75. 603 pages.

Introduction to Microwave Theory and Measurement

By A. L. Lance. Published 1964 by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 10036. Price $8.50. 308 pages.

Managerial and Engineering Economy: Economic Decision-Making

By George A. Taylor. Published 1964 by D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. Price $12.00. 487 pages.

Multidimensional Gaussian Distributions

By Kenneth S. Miller. Published 1964 by John Wiley & Sons, Inc., 605 Third Ave., New York, N. Y. 10016. Price $9.50. 129 pages.

Handbook of Electron Beam Welding

By R. Bakish and S. S. White. Published 1964 by John Wiley & Sons, Inc., 605 Third Ave., New York, N.Y. 10016. Price $11.50. 269 pages.

Elementary Circuit Properties of Transistors

By C. L. Searle, A. R. Boothroyd, E. J. Angelo, Jr., P. E. Gray and D. O. Pederson. Published 1964 by John Wiley & Sons, Inc., 605 Third Ave., New York 16, N.Y. Price $4.50. 306 pages.

Amplifier and Memory Devices: With Films and Diodes

Edited by N. Prywes. Published 1965 by McGraw-Hill Book Co., 330 West 42nd St., New York, N.Y. 10036. Price $17.50. 456 pages.

Selected Papers on Mathematical Trends in Control Theory

Edited by R. Bellman and R. Kalaba. Published 1964 by Dover Publications, Inc., 180 Varick St., New York 14, N.Y. Price $2.00. 200 pages, paperback.

Probability and Information Theory with Applications to Radar, 2nd Ed.

By P. M. Woodward. Published 1965 by Pergamon Press Book-The Macmillan Co., 60 Fifth Ave., New York 11, N. Y. Price $5.00. 136 pages.

Datadex Transistor Reference Book, 2nd Ed.

Written and compiled by D. G. Kilpatrick and W. A. Dittrich. Published 1964 by M. W. Lads Publishing Co., Phila., Pa. Sold through Electronic Parts Distributors by International Resistance Co., Phila., Pa. Price $3.95. 293 pages, paperback.

Project Estimating by Engineering Methods

By Paul F. Gallagher. Published 1965 by Hayden Book Co., Inc., 850 Third Ave., New York 22, N. Y. Price $15.00. 336 pages.

Elementary Electrical Network Theory

By D. G. Tucker. Published 1964 by Pergamon Press Ltd. and distributed by The MacMillan Co., 60 Fifth Ave., New York 11, N. Y. Price $2.95. 169 pages, paperback.

Fundamentals of Relay Circuit Design

By Alan R. Knoop. Published 1965 by Reinhold Publishing Corp., 430 Park Ave., New York, N. Y. 10022. Price $15.00. 312 pages.

A CONTACT MATERIAL for sliding electrical contacts developed by the Lockheed Missiles & Space Co. will operate in the high vacuum of space and last longer than normal material. Called CLB-ALLOY, the material will operate in vacuums with about 100 times less electrical noise than materials now used for electrical brushes.

DISPOSABLE INSTRUMENTS for oceanographic measurements has been suggested by Scripps Institute of Oceanography. By using instruments made with microelectronics, more accurate measurements could be made. Each time an instrument is used, it must be recalibrated. This could be eliminated with expendable units.

PROFESSIONAL GUIDELINES

Reporting late developments affecting the employment picture in the Electronic Industries

RESEARCH GOALS AND POLICY ARE MANAGEMENT DECISIONS

A New York management consultant believes that executives who fail to interfere with the direction taken by their research men are avoiding responsibility and are endangering perhaps their company's survival.

Dr. David Hertz, of McKinsey & Co., Inc., believes that managers are better at spotting research opportunities for their own firms than they sometimes realize. A recent McKinsey inquiry showed that half of the good research ideas developed in chemicals, electronic devices and drugs came from top management.

Industrial managers know the importance of R&D and are willing to pay for it, but they do not always know how to make it pay for them. They expect scientists and engineers to find the right questions as well as the right answers. Management art of high order needed to choose a problem that fits the markets, organization, talent, goals, and technical arts of the enterprise.

"When competent scientists fail to contribute to the enterprise," said Dr. Hertz, "it is either because they have not been attacking the right problems, or the firm does not know how to use the answers once they are found."

TECHNICAL STARTING WAGES RISE 3.1% OVER 1964

A report by the College Placement Council, National Society of Professional Engineers, on starting salaries of 1965 bachelor degree candidates indicates that on the basis of offers made to all students in technical fields by December 15, salaries show a rise of 3.1% over last year.

While the number of offers to nontechnical candidates rose at a greater rate, starting salary offers to nontechnicals increased by only 1.6%. Since the 1963-64 recruiting season, chemical engineering has overtaken the traditional leaders, aeronautical and electrical engineering. The average offer for chemical engineers was $639 a month. Current figure for electrical engineers is $637.00.

DESK-TOP UNIT DISPLAYS COMPUTER-STORED DATA

New IBM table-top device provides visual image of computer-stored information, and can help management of small and large firms maintain tight control over business activity. The 2260 can display insurance records, logs of customer calls, inventory-shipping data.

INDEX SHOWS FALL IN DEMAND FOR TECHNICAL MANPOWER

Demand Index for Scientists and Engineers showed 102.6 for February; a drop of 10 points from January. The current February figure, however, is 42.9% above the 1964 February figure.

Deutsch & Shea predicts a comparable level of demand will be maintained through March, followed—if the Index keeps to its usual pattern—by a moderate drop in April and May.

The current January to February dip follows a pattern set during the past four years in which the Index rose in January, then fell off in February of each year. This marks the first time since March—April, 1963 that the Index has remained above the 100.0 mark for two consecutive months.

The drop in recruiting and hiring activity was general throughout the nation except for the Midwest where demand level remained somewhat stable. There was a strong upsurge in demand in the chemical field in February. Demand in electronics and civil engineering remained stable.

MEDIAN SALARIES

The median salary of 224,000 scientists answering a 1964 survey by the National Science Foundation was $11,000. The NSF estimates that the survey covers about 75% of all qualified U. S. scientists.

The highest median, $12,000, was reported in physics, statistics, and economics. The lowest, $9,000, was reported in linguistics.

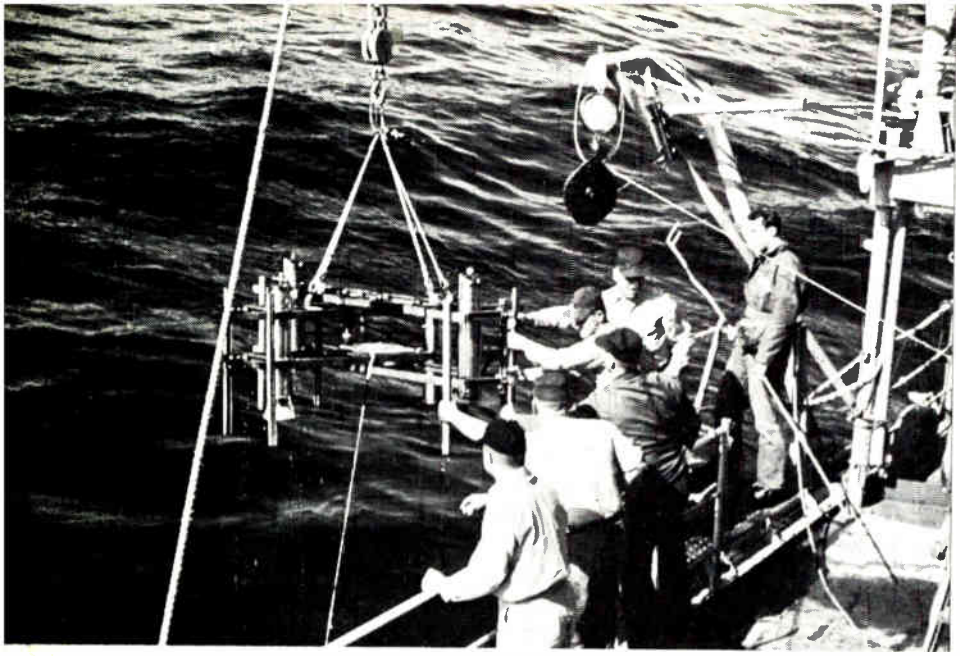
FOR MORE INFORMATION . . . on opportunities described in this section fill out the convenient resume form, page 124.

ENGINEER TECHNICIANS SET FOR FIRST ANNUAL MEET

Certified engineering technicians from every state are expected at the first annual meeting of the American Society of Certified Engineering Technicians (ASCET), to be held June 18-19 at the Schroeder Hotel, Milwaukee, Wisc.

In addition to luncheons and guest speakers, the two-day meeting will include a day of group meetings on problems and challenges in the engineering technician field.

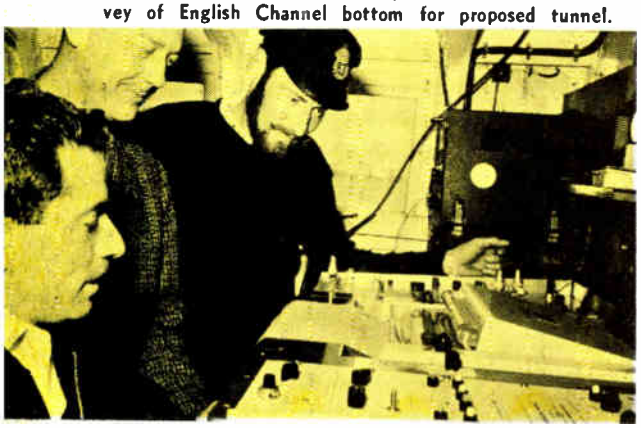
Further data may be obtained by writing directly to ASCET at 2029 K Street, N.W., Washington, D. C. 20006.



Underwater camera system with electronic controls, developed by Edgerton, Germeshausen & Grier, coming out of the water.

By SIDNEY FELDMAN
Associate Editor
ELECTRONIC INDUSTRIES

EG&G engineers and ship's captain view seismic survey of English Channel bottom for proposed tunnel.



OCEANOGRAPHY—

New Challenge for Equipment Designers

THERE ARE SOME 30 NATIONS CURRENTLY ACTIVE in exploring and exploiting the oceans for commercial and military purposes, including the U. S. Among these nations there are about 400 recorded vessels equipped for ocean study of one sort or another, operated by about 180 agencies, institutions, and associations all dedicated to science, commerce, education, government policy and/or the military.

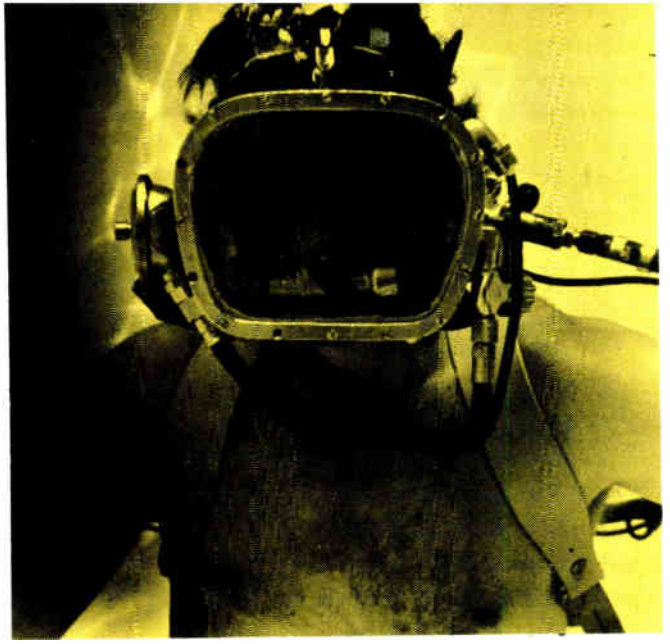
Of the oceanographic ships on record, the U. S. has the most in action (211). Our nation also maintains both the smallest and the largest ships for ocean study: the "Nomad" at 5 tons, operated by the Navy, and the 15,470-ton "Empire State IV" operated by the State University of New York Maritime College. Some 60 U. S. government and private agencies operate these vessels in our behalf, seeking answers to the mysteries of the deep in order to help our national economy, raise our standard of living, provide for possible future scarcity of food and minerals, or perhaps for the benefit of pure science. More private industrial oceanographic institutions and laboratories are under construction, or are being planned in this country.

What does all this mean? It means simply that, in the U. S. especially, a lot of money is being spent, and will be spent, for a very broad and broadening research activity. The eventual results are still open to question.

In 1958 the head of the United Kingdom's National Institute of Oceanography asserted that civilian support of oceanographic studies would be obtained only by showing practical uses. In 1964, the Committee on Oceanography, U. S. National Academy of Sciences—National Research Council (NAS-NRC) issued a report called "Economic Benefits from Oceanographic Research." The report was published because "the rapid growth of appropriations for oceanographic research raises legitimate questions as to its economic justification." We don't know at this point whether these legitimate questions were answered to anyone's satisfaction.

Government-Wide Budget

The U. S. Federal oceanography budget was planned in 1959 on a government-wide basis. Since Fiscal Year 1961, the plans have been published as "national programs" developed yearly through the Interagency Committee on Oceanography (ICO). The Committee represents the oceanographic interests of the Navy, Departments of Commerce, Interior, Treasury, Health, Education and Welfare; the National Science Foundation, Atomic Energy Commission and the Smithsonian Institution. In Fiscal Year 1965 these agencies have spent about $70 million of ICO's estimated $135.1 million oceanography budget.



New deep-water mask designed by Ocean Systems combines "demand system" breathing apparatus with a communications system.

Development of oceanography depends largely on Federal cash, Congressional understanding, industrial faith, relation to defense —and how the seas stack up as a repository of natural resources.

Nearly half ($65 million) of the ICO budget was spent by the Navy, which also spent about $41 million for ocean research. Of its estimated $14 billion total 1964 budget, the Navy spent about 0.8% for oceanography. The percentage is small but the Navy's money and efforts for oceanography are large in absolute terms, according to NAS-NRC. Finally, Navy expeditures for oceanography may average about $114 million yearly from 1964 to 1973, especially for anti-submarine warfare (ASW).

Ocean engineering and research covers many things of benefit to man, such as research in the cause of earthquakes, studies for power generation, monitoring of tidal waves and ocean currents, and desalting of water for drinking. Ocean engineering could help increase the world's available mineral resources. A 50% rise in such resources is anticipated if the continental shelves are fully exploited, and if other sub-sea areas are tapped. So estimates Dr. John W. Clark, coordinator of ocean engineering research at the Columbus (Ohio) Laboratories of Batelle Memorial Institute.

The Oceanography Committee of NAS-NRC foresees a number of civilian benefits by 1980. Among them are an increase of $3 billion in marine fisheries, mineral deposits, and recreation facilities. They also see a $3 billion saving yearly from better transportation, long-range weather forecasting, and near-shore sewage disposal.

Electronic Equipment/Systems

For our purposes, oceanography budgets must be narrowed down in terms of electronic equipment and systems. R. O. Romaine, sales and marketing vice president of Edo Corp., thriving ASW contractor, notes that more than 75% of ASW and oceanography budgets are for ship construction and maintenance, including payrolls.

Of the remaining 25%, he estimates 10% to 15% goes to technical services by groups including institutions, colleges and private laboratories. Accordingly, Mr. Romaine figures the electronic share of the oceanography market is about $3 million currently. This market may grow to about $10 million by 1974. Of the

Bathyscaph TRIESTE II for underwater search. Electronic equipment aboard includes: cameras, Xenon strobe flash, side-looking sonar.

$141.6 million ICO asked for Fiscal Year 1966, about $8.2 million is earmarked for improved electronic and non-electronic instruments.

The far larger electronic market lies in ASW. Mr. Romaine estimates this market at about $150 million yearly for electronic gear; it may grow to about $200 million by 1974. He concludes that "oceanography is receiving more publicity than dollars—but it is developing."

Many tools used for science study out of and away from the sea are blunted below the sea's surface. Down there the electromagnetic spectrum is effective mostly in acoustical frequencies. Sound is now used extensively as the basis for instruments that measure ocean currents, depths, analyze undersea terrain, and telemeter data. We are much in the dark on how oceans modulate sound waves. Once we find the key to reading ocean sounds, "man's mastery of the seas then will be at hand," observes Lawrence Gregory of Columbia's Hudson Laboratories.

Further views are offered by Donald L. McKernan, chairman, ICO Instrumentation, Equipment and Facilities Panel, which recognizes that ships are expensive platforms that may cost as high as $5 million each. To spend U. S. funds most efficiently, the Panel tries to

ELECTRONIC INDUSTRIES Professional Profile

Please type or print

The ELECTRONIC INDUSTRIES Job Resume Form for Electronic Engineers

Name _____ Tel. No. _____

Street Address _____ Zone _____

City _____ State _____

☐ Single ☐ Married ☐ Citizen ☐ Non-Citizen Date of Birth _____

Will Relocate ☐ Yes ☐ No. If Yes ☐ Another City ☐ Another State

Salary Desired to Change Jobs in present area _____

Salary Desired to Change Jobs and relocate in another area _____

Professional Memberships _____

College or University	Major	Degree	Dates

RECENT WORK EXPERIENCE

Company	Div. or Dept.	Title	Dates

SIGNIFICANT EXPERIENCE AND OBJECTIVES

STATE ANY FACTS ABOUT YOURSELF THAT WILL HELP A PROSPECTIVE EMPLOYER EVALUATE YOUR EXPERIENCE AND JOB INTERESTS. INCLUDE SIGNIFICANT ACHIEVEMENTS, PUBLISHED PAPERS, AND CAREER GOALS.

Mail to: ELECTRONIC INDUSTRIES—Professional Profile—56th & Chestnut Sts.—Philadelphia, Pa. 19139. This resume is confidential. A copy will be sent only to those Companies advertising for engineering personnel in this issue, whose number you circle below.

800 801 802 803 804 805 806 807 808 809 810

improve techniques for measuring ocean physical, chemical and biological properties; increase effectiveness in understanding the sea; and encourage development of instruments and mechanization of instruments aboard ship.

Ships-of-Opportunity

The Panel is now working on ideas for instruments usable on U. S. ships-of-opportunity, which might be vessels engaged in commerce or military activity that could be used for certain on-the-spot ocean studies where and when convenient. Such instruments, observe Panel members, should be designed to require little time or effort, no special skill, no change of vessel operation (and perhaps course), and yet must provide unquestionable data.

Such instruments might include: an electronic bathermograph with winch-wire boom-recorder-readout assembly, and an automatic recording sea-surface temperature probe-indicator. Other devices, considered but not yet applicable to ships-of-opportunity are: a sounding set, towed magnetometer, precision depth or graphic recorder, and shipboard wave-height measuring or recording device.

There are a number of interagency oceanographic instrument systems either in current use or in development fostered by the Panel. Among these are satellite systems to relay data from buoys and ocean platforms to national and international data centers. There are a number of different sensors now in use, but key parts of observational systems are critical. Further developments are needed for chemical and geological studies. Various undersea structures are in test and in planning stages, including communications and monitoring networks. More shore-based facilities are vital. Data reduction equipment must be improved to collate experimental information in short time. At the moment, a week of ocean study data may take as much as a year to collate and interpret.

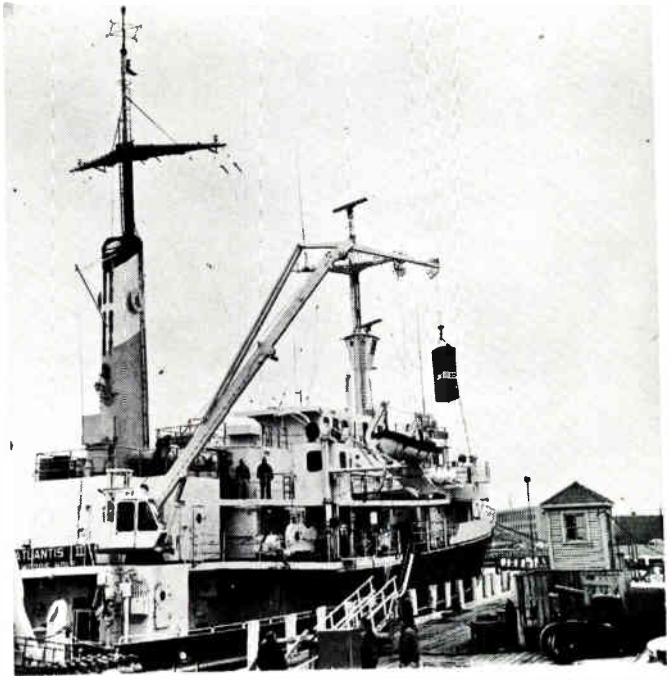
These and many other activities are being carried on by private enterprise. Old companies are diversifying from ASW into commercial oceanography. New firms keep entering the field. Joint ventures, mergers and acquisitions continue to broaden the stake of U. S. industry in oceanography.

Firms in Oceanography

Seaworthy names in ASW/oceanography sonar include Raytheon, Bendix-Pacific, Edo, General Electric, and Sangamo. Others are Clevite, Dyna-Empire, General Instrument, Hazeltine, and Magnavox.

Raytheon's broad-based East and West Coast marine electronic operations range from consumer-commercial radiotelephones and fish-finders, to heavy sonar systems.

Record profits recently have been earned by smaller firms specializing in oceanography systems and services. These include Edo Corp., Alpine Geophysical Associates, and Edgerton, Germeshausen & Grier.



Part of a PDP-5 computer from Digital Equipment Corp. is swung aboard the Atlantis II, research ship of Woods Hole Oceanographic Institute. The computer will process ocean data and also will be used to navigate the ship by analyzing signals from satellites.

Alpine converted an 80-foot fishing vessel for oceanography, especially equipped for continental shelf investigations. It has made studies for Army Engineers' Offshore Sand Inventory Program, investigated sites for the San Francisco Trans-Bay Tube, harbor projects in New Zealand, offshore petroleum, and projects in Antarctica and the Indian Ocean.

EG&G's oceanographic service work includes sonar surveys of the English Channel for a proposed England-to-France tunnel, and a major part in finding the lost nuclear submarine Thresher. That search has spurred the Navy's Deep Submergence Project to develop techniques and equipment for deep sea exploration, rescue and salvage. About $200 millions may be spent on this program from FY 1966 through FY 1970.

Westinghouse is "strengthening" its oceanography

(Continued on following page)

INDUSTRIAL INTEREST RISING

Up to 6,000 companies provide and use electronic components, equipment and services in ASW and oceanography. About 525 firms were represented at the Government-Industry Symposium on Oceanographic Instrumentation in August 1961. Some were fishing for business, while others were deep in oceanography.

The industry's pulse again will be taken at the world's first ocean sciences and ocean engineering conference-exhibit, June 14-17, 1965, at the new Washington Hilton Hotel. Co-sponsors are the Marine Technology Society and American Society for Limnology and Oceanography.

Other groups interested in oceanography include the Institute of Electrical and Electronics Engineers, Instrument Society of America, American Institute of Biological Sciences, American Chemical Society, and American Geophysical Union.

OCEANOGRAPHY (Continued)

position, by acquiring companies, opening a new laboratory, and increasing services. It offers trained personnel, leases facilities and equipment such as support ships, sensing devices and manned submersible vehicles. Around 1975 oceanographic engineering and research may represent about 10% of Westinghouse business.

Both Westinghouse and a newly-formed joint venture, Ocean Systems, Inc., have man-in-the-sea programs. OS involves Union Carbide, General Precision, and Edwin A. Link, the oceanographer-inventor of the Instrument Flight Trainer. General Precision will concentrate on communications, ranging from closed-circuit-TV to electronic facsimile.

400 Feet for Divers

Ocean Systems' special equipment has extended working depths of individual divers to more than 400 feet, and eventually may extend to 1,000 feet. That is the general limit of relatively shallow seas over the continental shelf of offshore land used for ocean engineering purposes. Observers remain inside Westinghouse's diving vehicles that go beyond the continental shelf. Its diving saucer descends to 1,000 feet. The company is developing a family of Deepstar submersibles, to go down to 4,000 to 20,000 feet.

Westinghouse's Underseas Division recently sought degreed specialists, including electronic engineers, with three-to-ten years of experience in underseas technology. Its new Chesapeake Bay facility may employ about 300 persons, then grow to about 500. A government contractor recently advertised for "head of oceanic sciences research." Requirements were a Ph. D. (or equivalent) in physics, or EE with at least five years of post-doctoral research, broad knowledge of electronic systems analysis, and physics of ASW underwater sound systems.

Oceanographers are hard to define, harder to count. They are "scientific sailors or scuba divers who are

(*Continued on page* 128)

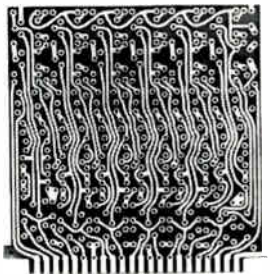
SOURCES FOR OCEANOGRAPHIC CURRICULA

Institutions which give courses in, or pertaining to, oceanography include: Agricultural and Mechanical College of Texas; Graduate School, U. S. Department of Agriculture; University of Alaska; The American University; California Institute of Technology; University of Chicago; University of Connecticut; Columbia University; Cornell University; University of Delaware; Duke University; Florida State University; University of Georgia.

Also: Harvard University; University of Hawaii; University of Houston; Humboldt State College; Johns Hopkins University; Louisiana State University; Massachusetts Institute of Technology; University of Miami; University of Michigan; U. S. Naval Postgraduate School; New York University; State University of New York Maritime College; University of North Carolina; Northeastern University; Oregon Institute of Marine Biology; Oregon State University; University of the Pacific.

Other institutions are Pennsylvania State University; Pomona College; University of Puerto Rico; Rensselaer Polytechnic Institute; University of Rhode Island; San Diego State College; Scripps Institution of Oceanography; University of Southern California; Stanford University; University of Texas; Virginia Institute of Marine Sciences; Walla Walla College; University of Washington; University of Wisconsin, and Yale University.

Photocircuits can solve your PRINTED CIRCUIT PROBLEMS



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

SOLDERABILITY TROUBLE

PROBLEM: We manufacture low-cost radios and intercoms. In the past 6 months, soldering problems have substantially increased manufacturing costs, through excessive inspection and touch-up time required after wave soldering. Nothing seems to help. Have you a suggestion?

SOLUTION: The new CC-4 printed circuit process may be your solution. This patented technique deposits ductile copper which, according to one user's letter, "solders like a dream." As to cost-cutting — customers report an up-to-80% reduction in after-soldering touch-up and inspection costs as a result of CC-4 using printed circuits.

MINIATURIZING WITH MULTILAYER

PROBLEM: Five years ago we considered converting some of our miniaturized designs to incorporate your newly-developed multilayer printed circuits. We found the price too high. Has today's price-picture changed?

SOLUTION: The situation has changed radically. Chances are the cost of what you need would be about 50% lower today — although an exact figure would be unrealistic without seeing your actual boards. Multilayer use is increasing so rapidly that we anticipate another 50% cost reduction during the coming year. *Caution*: Be sure not to compare the cost of one 8-layer multilayer to just the piece-cost of four two-sided boards with an equal interconnection capability. Many manufacturers adopt multilayers after an analysis of system interconnection costs, including such factors as eliminated hardware, reduced assembly labor, and lower inspection expense — all important cost-cutting advantages of using multilayer printed circuits.

HOW DO PERSONNEL GET PRINTED CIRCUIT KNOW-HOW?

PROBLEM: We are diversifying into a type of equipment requiring printed circuits. None of our engineers is very familiar with them. Our men are faced with specifying printed circuit base materials, platings and tolerances. How can we train some of them so they can intelligently design and specify printed wiring boards?

SOLUTION: Our Standard Circuit Division was specifically set up to help medium-quantity users of printed circuits who need to cut through time-consuming procurement procedures. It manufactures a range of boards with a limited number of choices of such variables as base materials, platings, tolerances, etc. These can be combined to fulfill a wide variety of manufacturing requirements — with the least possible loss of time, and at the lowest possible cost. The Standard Circuit Division greatly simplifies your procurement, permits a minimum of paperwork, reduces board costs and delivery times, and completely eliminates tool charges! It even permits published price lists, so you can figure your own printed circuit costs in advance.

PRINTED CIRCUIT PATTERNS FROM PENCIL SKETCHES

PROBLEM: Our Drafting Department prepares our printed circuit artwork-masters from pencil sketches provided by Engineering. Every time we have a rush program, the workload in Drafting always seems to be abnormally heavy and we fall 2 or 3 weeks behind schedule waiting for artwork. Is there a way to get printed circuit patterns faster?

SOLUTION: Oversized master artwork for printed-circuit patterns is not only slow, but subject to error — and unnecessary! The Master Circuit System, developed by Photocircuits, converts an engineer's pencil-sketch into accurate 1:1 circuit patterns quickly and inexpensively, by means of recently-developed automatic equipment. Documentation is greatly simplified, too. Photocircuits' six MCS machines can handle over 300 patterns per week, to handle your rush requirements. Incidentally, the Master Circuit System slashes time and costs for multilayer artwork even more drastically.

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

Photocircuits
CORPORATION
Glen Cove, New York • Anaheim, California

OCEANOGRAPHY (Continued)

jacks of several trades." They may be physicists, chemists, biologists, geologists, metallurgists, mineralogists, or other specialists. Sea water covers nearly three times as much Earth surface as does land. Yet there are far fewer oceanographers, compared with tens of thousands of scientists studying the land and the sky.

Nobody knows how many electronic engineers serve in oceanography work. The National Science Foundation reports about 3,000 professionals (bachelor's degree or equivalent, plus higher degrees) in the field. They are active in physical, biological, fisheries, or engineering activities. Most have degrees in fields other than oceanography. Program budgets for oceanography have been growing at the rate of about 10% annually. Personnel requirements are increasing more slowly, yet upwards.

Engineer Cross Section

Raytheon reports engineers doing oceanography work average about 30 years of age, have a college degree ranging from electrical to chemical engineering, and many have a master's degree. Salaries of ASW/oceanography engineers broadly range between $7,000 and $20,000 annually.

An oceanography background is exemplified by Commander John O. Phillips, 45, chief, Geodesy Division, Coast and Geodetic Survey—the Commerce Department's "Navy." For 23 years he has served this agency. He is a civil engineer from Carnegie Institute of Technology. Commander Phillips studied radar at Bowdoin College, and Massachusetts Institute of Technology, and oceanography at the University of Washington.

By contrast, a professor who used to teach low-density aerodynamics at a California university, became an oceanographer. A shortage of students in the school's aeronautical department led him to redirect his efforts.

In November 1962 only 36 U. S. universities taught

NATIONAL OCEANOGRAPHY BUDGET

Interagency Committee on Oceanography (ICO) predicts a $2.3 billion overall national oceanography budget through 1972. Disposition of these funds shows:

- **36% improving national defense***
- **23% strengthening basic science**
- **19% resources in the world ocean**
- **12% services**
- **8% resources in domestic waters**
- **2% protection of lives and properties.**

A breakdown of funds by ICO functional areas shows:

- **57% research**
- **22% ships**
- **10% surveys**
- **4% instrumentation**
- **4% facilities**
- **2% international programs**
- **1% data center.**

*Budget for Anti-Submarine Warfare, including aircraft and missiles, is estimated at $2.2 billion currently. Expenditures for ASW research, development, test and evaluation, are estimated at $386.5 million.

U. S. FUNDS to PROBE the SEAS

Federal Obligations for Oceanographic Research, Surveys and Facilities (including ship construction) reported by the Bureau of the Budget, are:

Fiscal Year	Obligations (in millions)
1958	$ 17.4
1959	25.2
1960	55.0
1961	62.0
1962	103.7
1963	123.7
1964	123.1
1965 (estimated)	135.1
1966 (estimated)	141.6

subjects mainly with "oceanographic implications." For the 1963-64 academic year, 45 schools offered "oceanography" subjects grouped chiefly under: Oceanography, Fisheries, Marine Biology, and Marine Geology.

Courses included: mathematics, physics, chemistry, zoology, and foreign languages—chiefly French, German or Russian. (Other countries with expanding oceanography programs include the United Kingdom, U.S.S.R., Canada, and Japan.) At the University of Miami, Coral Cables, Florida, the School of Engineering and Institute of Marine Science offer a joint program. Graduate courses include underwater acoustics, engineering problems, electronic systems, advanced solid state devices, systems analysis, and data processing. Research areas include marine bio-acoustics; underwater communications, photography and television, and instrumentation.

Famous regional oceanography organizations include the Woods Hole Oceanographic Institution on the East Coast, and the Scripps Institution of Oceanography on the West Coast. Latest proposed oceanographic institution is the Gulf Coast Marine Sciences Center, which may be located at Galveston, Texas. It is planned by the Gulf Universities Research Corp., Inc., comprising Florida State, Louisiana, Rice, Southern Methodist, Texas A & M Universities, and the Universities of Houston and Texas. Scientific studies would include marine biology and meteorology, air-sea interaction, physical and chemical oceanography, seismology, gravity, geology and geomagnetism.

"In oceanography in 1965, we are about where we were in meteorology in 1930." So states Rear Admiral Denys W. Knoll, U.S.N., Oceanographer of the Navy. He scores our submarine weapon system as being far more sophisticated than our understanding of the seas.

Since 1958 Federal oceanography budgets have been more than quintupled. Far greater sums are being spent for ASW. Future markets and engineering jobs depend upon how Congress views oceanography. That decision must be made in relation to defense and aerospace spending, and in consideration of oceans as a natural resource.

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

WHAT'S NEW

LOW COST MASS CORE MEMORY

A SIGNIFICANT REDUCTION IN THE COST OF CORE MEMORIES is realized with the Megabit 53.12 Memory system. The memories are offered in 5 million bit capacities, and as many as eight of these modules may be combined for an expanded system. Cycle time per unit is 12μsec. Access time is 2μsec. Cost per bit is about 2 cents.

Minimum configuration contains 256 x 256 words, each word driven by one switch core. All cores are threaded by a third wire carrying a bias current. Finally, each switch core is threaded by a fourth wire which couples the switch core to the 76 memory cores of one word. One switch core, and thereby one word, is isolated by selecting one out of the 256 "X" wires and one of the 256 "Y" wires.

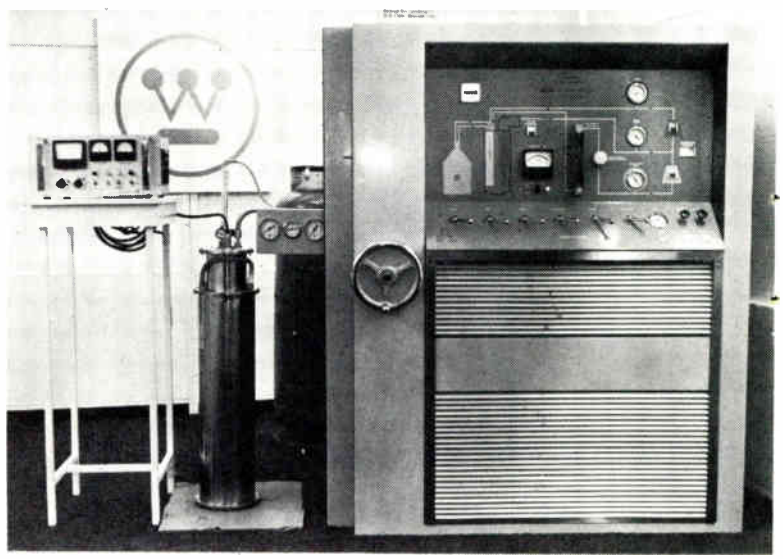
To use as few selection switches as possible, selection occurs through a switch-core matrix. The switch cores, in turn, are coincident current selected. To maintain simple design within the stack itself, the same wire is used for both sense and inhibit. Using one wire for both these functions places tight design requirements on the read amplifier, since it must recover from the inhibit noise quickly enough to detect a "0" or "1" output microseconds later. This recovery time, not only in the read amplifier but also in the stack, allows for decaying transients and is one of the main parameters governing cycle time.

To avoid overdrive of the read amplifier, the bit wire is intersected in four identical parts. These four sec-

SUPERCONDUCTING MAGNET OPERATES

IT MAY SOON BE POSSIBLE TO APPLY SUPERCONDUCTING TECHNIQUES to a wide range of problems outside the

Closed-loop helium unit maintains super-conductivity unattended.



Reduced size of memory plane is shown by this 10K bit/plane.

tions are connected in a bridge circuit which is driven by the inhibit source across one diagonal, and sensed by the read amplifier across the other diagonal. To accomplish this in the actual unit, the memory array is constructed of four independent modules. Each module contains ¼ the 65K and 76 capacity. The common sense and inhibit wire from each module is connected to the four respective corners of the balanced bridge.

The system is a product of Ferroxcube Corp. of America, Saugerties, N. Y.

UNATTENDED

laboratory. This is possible because Westinghouse Corp., Pittsburgh, has succeeded in maintaining a magnet in the superconducting state, unattended, by using a closed-hoop helium refrigerator.

Until now, most superconducting magnets have been maintained in the superconducting state by immersing or surrounding them in a container filled with supercooled liquids. Operation was limited to the time required for the refrigerant to evaporate, and by the need for periodic replacement of the refrigerant. The new system, called the Cryodyne Helium Refrigerator, is designed to operate unattended. Helium gas at 250 psig is precooled by liquid nitrogen, then by a helium refrigerator. At 15°K the gas enters a Joule-Thomson expansion circuit and a portion is liquefied directly into the magnet operating Dewar. The remaining cold gas returns through the system to the compressor.

The magnet used in this experiment produced 50,000 gauss in an eight-cubic inch working volume. Its weight was 15 lbs.

Try These Two New Additions To Your

INTRODUCTION TO EDP

TEACH YOURSELF...

- The role of computers in business organizations.
- The computer as a problem-solving tool.
- Elements in computer programming.
- Symbolic and machine language concepts.
- The computer's central processor.
- System flowcharts—input and output format.
- Hardware and software concepts.

JUST RELEASED

READING & EVALUATING FINANCIAL REPORTS

LEARN HOW TO...

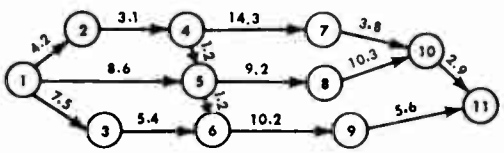
- Read and understand income statements and balance sheets
- Identify critical items and trends
- Evaluate the strength of your company
- Compare stocks for investment.
- Conduct professional ratio-analyses.

TEST YOUR SKILLS IN THESE ELECTRONICS GROWTH AREAS

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 7 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.

PERT



12. Examine the network you have just constructed.

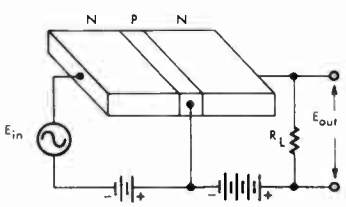
(a) Identify the critical path by giving the sequence of events along the path: _____.

(b) Give the T_E which you calculated for the ending event of the network _____ weeks

(c) 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

(d) If the changes mentioned in (c) 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?

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:

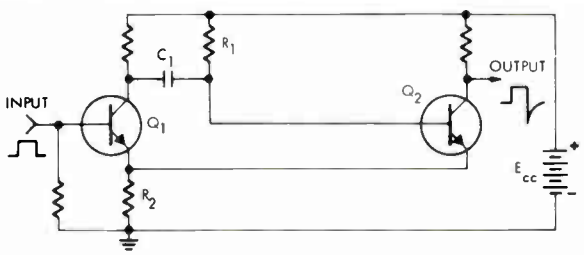
A. base-collector junction 1.___high impedance

B. emitter-base junction 2.___input impedance

3.___low impedance

4.___output impedance

BASIC TRANSISTOR CIRCUITS



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.

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"Engineer's Job Mobility" Series!

CAN YOU REALLY AFFORD THE TIME TO UPGRADE YOUR KNOWLEDGE IN THESE ELECTRONICS GROWTH AREAS?

Most people **can't** take the time to search the literature, return to school, or take lengthy correspondence courses. So thousands of engineers and technicians are turning to PROGRAMMED INSTRUCTION, a new teaching technique based upon the findings of behavioral psychologists.

You are led through a carefully designed and tested self-instructional program in which the subject matter is carefully structured and presented in increasingly complex steps which assure that you will attain maximum learning in minimum time. This is why Programmed Instruction is "an ideal way to train engineers in technical subjects – they learn 10% to 25% more in half the time," according to Russell S. Pease, Engineering Consultant at Du Pont.

PROGRAMMED INSTRUCTION COULD BE THE ANSWER FOR YOU—TAKE A LOOK AT THE PERFORMANCE DATA:

With the 5 subjects now available as the initial courses in a new programmed instruction series, you can master an entire subject in a day—and score 90% or better on a comprehensive final exam.

For example, when engineering members of the American Materials Handling Society took the PERT program at home in their spare time, they averaged 12.2 hours to complete the program and scored 90.1% on the final exam. Here is their individual performance data:

Job Title	Foreman	Ops. Mgr.	Proj. Eng.	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
Age (yrs.)	36	22	44	48	52	47	47	50
Score (%)	94	97	97	94	92	87	80	79

FOLLOW THESE THREE SIMPLE STEPS:

To rate your own performance and skill needs in these subjects:

1) **Send for your 10-day review copies of the self-instructional programs.**

2) **Try the final examination included with each program.**

3) **If you are convinced that the skills imparted by the program are valuable, honor the enclosed invoice. Otherwise, return the programs and completed exams and pay nothing.**

Name_____

Title_____

Address_____

City_____ State_____

Company_____

☐ My check or company purchase order is enclosed.

☐ Bill me or my company directly.

Clip and send this coupon to:

Please send me the programs designated below. At the end of 10 days, I'll either send the indicated price, plus a few cents for packing and postage, or return the program and my completed final examination and owe nothing.

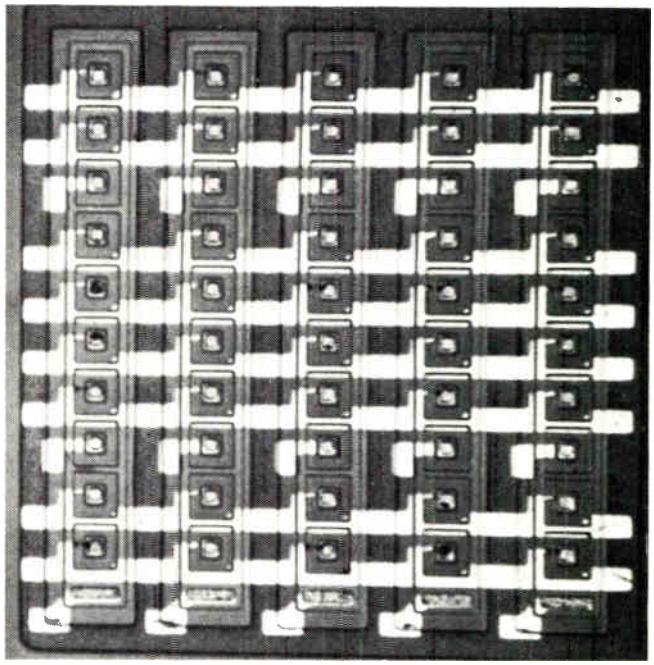
TITLE	PRICE	
Introduction to Electronic Data Processing	$9.50	☐
Reading and Evaluating Financial Reports	6.75	☐
PERT	12.50	☐
Introduction to Transistors	9.50	☐
Basic Transistor Circuits	9.50	☐
Counting Systems and Binary Arithmetic	7.50	☐
Applied Electricity	12.50	☐

BASIC SYSTEMS INCORPORATED 880 THIRD AVENUE/NEW YORK, N.Y.

DIODE MATRIX ALLOWS CUSTOM DESIGNING

A UNIQUE FABRICATION TECHNIQUE, developed by Radiation Inc., Melbourne, Fla., allows customers to specify diode interconnect patterns at no extra cost. The

Diode matrix can be packaged in TO cans or flat packs. A ¼ x ⅛ in. flat pack will accommodate up to a 5 x 8 matrix.



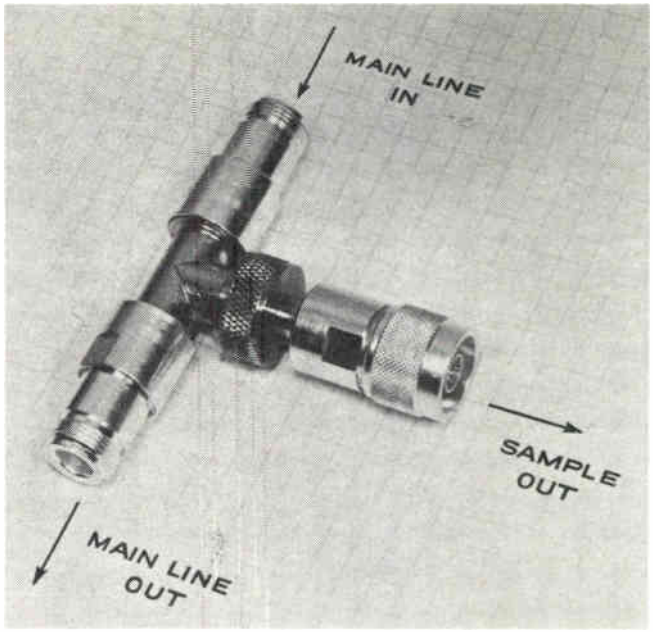
AT NO EXTRA COST

matrix can be packaged in any number of configurations.

The matrix is made with all diodes interconnected. These are then tested on programmed test equipment which provides a punched card output. This card is then used when customizing the interconnect pattern. The elimination process for unwanted diodes is basically that of burning out the fuse.

Isolation in these monolithic circuits is accomplished by the Waffle Wafer ™ technique. Here the diodes are arranged in columns and rows. The diodes in the columns have their commons within bulk silicon. Those in the rows have their commons interconnected with a deposited metalization. The Waffle technique essentially eliminates the parasitic coupling associated with P-N junction isolation. Isolation breakdown between columns is 1kv; isolation leakage at 50v. is 0.1na. Capacitance coupling is reduced by more than an order of magnitude over a normal P-N junction. The Waffle technique allows low resistivity moat areas to be used to facilitate low bus resistance for diode interconnects with the bulk silicon. This is accomplished without increasing coupling capacitance.

A wide range of diode characteristics is available: I_f from 10ma to 100ma; BV_R 50 to 100v.; diode recovery time down to 10nsec. Diodes are epitaxial, planar passivated silicon. (*More What's New on page* 136)



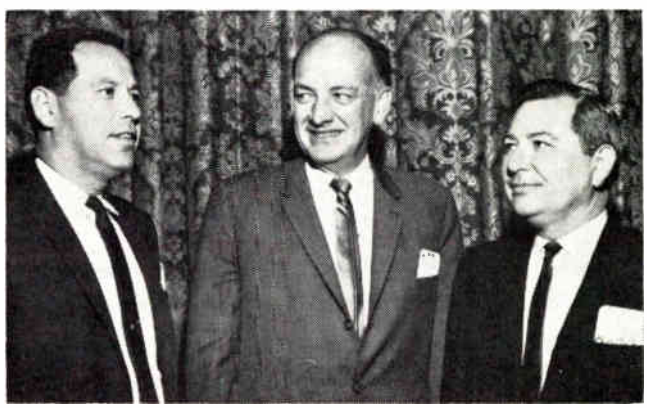
For freq. sampling and power monitoring, TSS-1 has N male and female connectors for attachment to main line or off line.

BROADBAND SIGNAL SAMPLER HAS ADJUSTABLE CAPACITY

A NEW SIGNAL SAMPLING DEVICE FOR R-F AND MICROWAVE CIRCUITS uses capacitive coupling and adjustments to take a sample from the main signal line.

The unit, Model TSS-1, covers all freqs. through X-band (12.4GC). It is basically an r-f T connector with a movable leg. Capacitance between the signal line and sample line is varied by moving the leg towards or away from the main line. The coupling is adjustable from less than 10db to over 40db. Main line VSWR depends on the degree of coupling, e.g., coupling of 10db results in a typical VSWR of 1.3:1 or less. Dissipation losses are negligible. The unit is a product of Telonic Engineering Co., Laguna Beach, Calif.

NEW EIA SUBDIVISION OFFICERS



S. L. Levy (left) manager of Integrated Circuits Product Marketing for Motorola Semiconductor, named chairman of new Microelectronics Subdivision of EIA. Center is Harper Q. North, EIA president, and vice president of R&D, Thompson Ramo Wooldridge, Inc., and Harry Owen, engineering director, Texas Instruments, Inc., who has been named vice chairman of the Subdivision at EIA Washington meeting.

INTERNATIONAL NEWS

London—Digital Measurements Ltd. says it has delivered the world's most accurate digital voltmeter (DM2010) to the Marconi Co. A prototype was shown at the I.E.A. Exhibition last June.

Hitchin, Hertfordshire—A new optical programmer using photo-electric relays to take data on a plastic disc provides intricate or rapidly changing programs beyond scope of cam timers, according to Elcontrol, Ltd.

London—Telex network detection equipment, claimed to reduce errors in transmission circuit to negligible proportions, has been developed by AEI, Ltd. for the British Post Office. It is for use on both-way telex and private telegraph circuits.

Greenford, Middlesex—Churchill Instrument Co., Ltd., announces its appointment as British representatives for TECHNITRON, concessionaires to a group of leading U.S. aviation and electronic instrument manufacturers.

Cardiff—British Railways Board will install three Honeywell 200 computers to keep track of more than 27,000 pieces of rolling stock in the South Wales area. Two units will operate as a real-time system for car status. The third will process business data.

London—First user installation in Europe of a Honeywell H-200 data processing system is now in operation at the New Southgate, North London, plant of Standard Telephone and Cables Ltd. System is being used for integrated production control.

Hayes, Middlesex—A system for control of conveyors and observation of transfer points in mines from remote locations has been developed by EMI Electronics Ltd. Flow of minerals can be monitored on a bank of closed-circuit TV sets.

Hanover—An international electronics congress, in conjunction with the Institute for Electrical Plant and Control Technology at Hanover Technical College will be held on April 28 and 29 as a feature of the 1965 Hanover Fair. Congress theme will be "Electrica and Electronic Aspects of Industrial Automation."

Rome—An automatic telemetry tracking system has been installed in Sardinia for the European Space Research Organization. Designer and builder is Electronic Specialty Co. of Los Angeles.

Paris—Supreme Headquarters Allied Powers in Europe (SHAPE) has chosen Marconi transportable microwave link equipment for an Allied Command Europe (ACE) communications system requirement. Marconi Italiana of Genoa received the contract.

Copenhagen—Danish P.T.T. has ordered 26 remote control systems from Telefunken for control and monitoring of unattended repeater stations as a phase of the organization's automation program.

Copenhagen—A new marine, sales, service and tranining center has been established by Raytheon Co. in the Danish capital. Facility will stock special parts and equipment for Raytheon radars, sounders, and other radio gear.

Stuttgart—The town exudes Radio Fair atmosphere as the mercantile and industrial populace get ready for the German Radio Fair for 1965, set for August 25 to September 5. Highlight of the Fair will be the "Funkball"—Radio Ball—to be held in Stuttgart Liederhalle, August 28.

Dublin—Irish International Airlines will install a Bunker-Ramo Corp. computer system to handle its growing reservation workload. It will be first fully automated system linking Ireland and Great Britain.

Tokyo—Nippon Electric Co., Ltd., a leading maker of telecommunications and electronic equipment in Japan, elected Dr. Koji Kobayashi as its new president at a recent general meeting of shareholders.

Melbourne—Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia has purchased an EAI 8800 Scientific Computer System from Electronic Associates, Inc. System will be used at CSIRO's chemical engineering division.

Malaga—A modern, $4 million, 149,000-sq. ft. telephone manufacturing plant of ITT's Spanish associate, Compania Internacional de Telecomunicacion Y Electronica, is now in production. It is geared to produce several hundred thousand telephone sets per year to meet Spain's fast growing demand.

IBM.
INDUSTRIAL
PRODUCTS
DIVISION

IBM 12-pole wire contact relays give you 200 million operations ...at 45¢ per pole

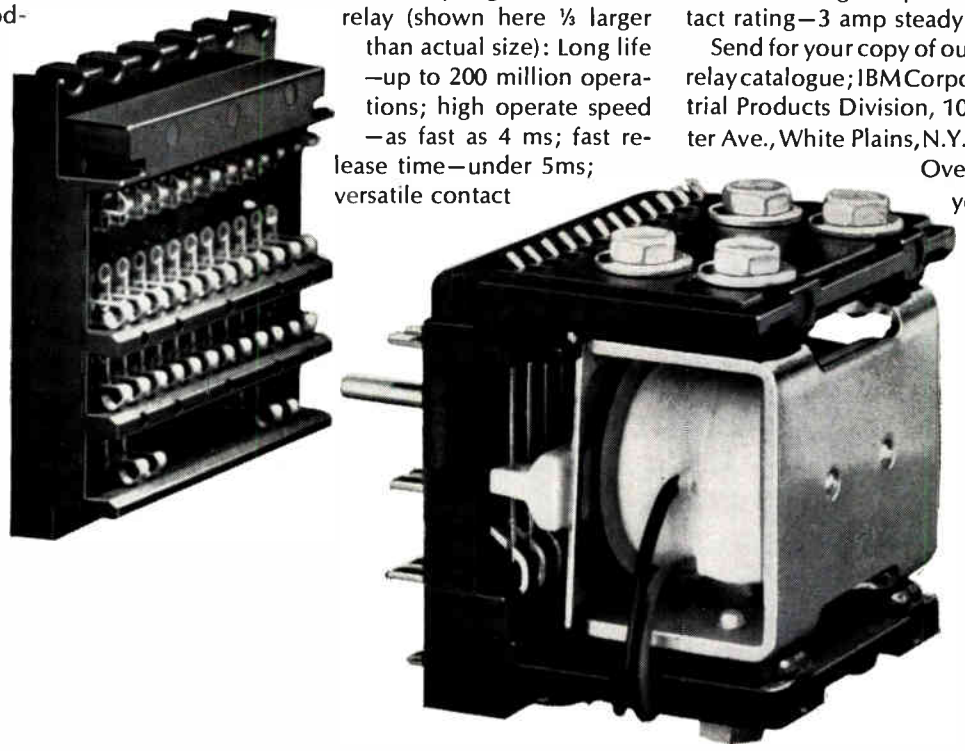
Low price. High performance. Pluggable. Fast delivery. And more.

Solderless connections, multiple coils, compactness and standardized mountings give you... lower manufacturing costs...lower initial product costs...lower product servicing costs.

IBM 12-pole relays start at $5.40, 4-poles at $2.90, latch relays at $8.45. (Even less in quantity.) And, they're available for fast delivery.

Use these IBM wire contact relays for counting logic switching, shift registers ...communications, process control data processing, and many others.

Here's what you get with an IBM relay (shown here ⅓ larger than actual size): Long life —up to 200 million operations; high operate speed —as fast as 4 ms; fast release time—under 5ms; versatile contact arrangements—4, 6 and 12 PDT, Form C, 4 and 6 PDT latch; maximum reliability—1 error per over 400 million contact closures at 48 VDC is attainable; variable coil voltages—up to 100 VDC; contact rating—3 amp steady state.



Send for your copy of our wire contact relay catalogue; IBM Corporation, Industrial Products Division, 1000 Westchester Ave., White Plains, N.Y. 10604.

Overseas, contact your local IBM World Trade Corporation office.

INTERNATIONAL NEWS

London—Major gains in computer sales in England and the continent are attributed to doubling of work force in past two years by Honeywell Controls, Ltd. Current 4,000 employees is "forcing" the firm to occupy a new 12-story building in London.

London—Standard Telephones and Cables Ltd. has expanded its service for measurement and suppression of radio interference in industry. Screened rooms, staff, facilities for on-site testing have been added to the service.

West Berlin—Telefunken A.G. has announced several new electron tubes, including a new 11" TV picture tube, metal-shielded, and suitable for battery operation, using only 0.75w.

Harwell, Berkshire—United Kingdom Atomic Energy Research Establishment at Harwell has received first delivery of new British magnetic thin film store system from EMI Electronics Ltd.

Melbourne—A new industrial instrument plant is being built in Lillydale, Greater Melbourne, by Foxboro Pty, Ltd., subsidiary of Foxboro Co. On a 32-acre site, the facility "will serve instrument needs of process plants throughout Australia."

The Hague—A new lubricating oils distillation plant under construction at Shell Nederland Refinery in Pernis, will be operated and controlled by a Honeywell 620 digital computer system.

Tokyo—Fujitsu, Ltd., and its U.S. associate, Marquardt Corp., have been contracted by Japanese Self-Defense Force to produce automated air defense training systems. Contract may be for $2.2 million.

Tokyo—Shigoto International Corp. announced a newly expanded line of miniature battery-operated magnetic dc motors for 1965, available through the firm's New York City office.

Karachi—Marconi 60-series airborne communications and navigation equipment has been ordered for three Hawker Siddeley Trident aircraft shortly to enter service with Pakistan International Airlines Corp.

SECRET SPYGLASS

Can see objects clearly in pitch darkness. Unit, developed by ITT, is self-contained device that converts infrared to visible light with a special tube — a high-resolution converter. Will be used by military, for law enforcement, and in industry, such as in dark-room inspection of processing film.

FIELD RADAR IDENTIFIES MOVING OBJECTS AT 22 MI.

A battlefield radar system so sensitive that it will spot a moving person at 9 miles and a moving vehicle at 22 miles, has been developed by Laboratoire Central de Telecommunications (Paris), subsidiary of ITT Corp.

The system is a pulse radar using Doppler effect for canceling stationary targets. For moving targets it has a maximum range of 22 miles on a single vehicle and of 9 miles on a single pedestrian. Accuracy is within a quarter degree in azimuth and 65 feet in range.

Moving targets appear as bright spots while fixed targets are displayed or eliminated as needed. The operator uses manual tracking while listening for Doppler sounds identifiable with objects such as wheel or track vehicles, or one or more pedestrians. The equipment can be transported by helicopter.

REPORT WRITING SEMINAR

"Preparing Clear, Concise Reports," a five-day seminar, will be offered at Arthur D. Little, Inc., Cambridge, Mass., from May 24 through May 28. The seminar will be given by William J. Gallagher, Associate Manager of Communications Services, and is aimed at providing guides and aids to scientists and businessmen in preparing reports. Inquiries about the course may be directed to: Mrs. Eileen Furth, Arthur D. Little, Inc., 20 Acorn Park, Cambridge, Mass., 02140.

HIGH SPEED SYSTEM SENDS NEWSPAPER PAGE OVERSEAS

High speed data transmission equipment has allowed transatlantic production of a newspaper page for the first time. The equipment, made by ITT's Standard Telephones and Cables Ltd., was used on both ends of the line, in London, and Wilmington, Mass.

From British headquarters of the Thomson Group Newspapers a unit, no bigger than a suitcase, sent a computer output tape holding all copy and layout to another unit in Wilmington where the newspaper, ready for Web-offset printing, was produced by Photon, Inc. To prove that it was done, a copy of the newspaper — "Evening Post"—was sent back to Thomson House over a normal facsimile link.

Data is transmitted on seven track paper tape over a two-way telephone circuit at the rate of 80 characters a second. To minimize typographical errors, the transmission equipment uses an exclusive error detecting code that gives an improvement of 15,000 times over the use of a link without this protection.

MANAGEMENT MEETING

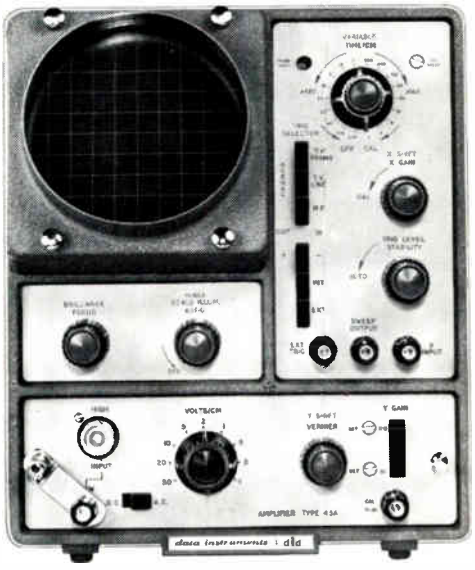
A three-day management conference on "Economic Aspects of Research Management" will be held at the Technological Institute of Northwestern University, Evanston, Ill., June 9-11. The conference is sponsored jointly by American Society for Metals and The Metallurgical Society of the American Institute of Mining, Metallurgical, and Petroleum Engineers. Registration for members is $150; nonmember fee is $200. Fees include instruction materials and luncheons.

ELECTROMAGNETICS COURSE

A 3-week course in electromagnetic propagation will be presented by the Electrical Engineering Dept. of the University of Colorado, in conjunction with the Boulder Laboratories of the National Bureau of Standards (NBS). The course, June 28 through July 16, will concentrate on fundamentals of electromagnetic propagation, advances in research and applications of theory to design and development. A two-week preparatory course on electromagnetic fundamentals will be offered June 14 to 25. Tuition is $200 for the preparatory course, and $300 for the main course; tuition for both is $400.

What do you need— a status symbol or a scope?

$365.



Now you have a choice—Data Instruments S43. For those who do not need the extras but who require reliability and performance in the essentials, it is the finest scope available. True, it concedes something to the glamor versions in the number of knobs—but it concedes nothing in way of performance or engineering. The main frame features a 4 inch precision flat face tube in a variety of phosphors with controlled edge lighting. A built-in time base provides sweep speeds up to 1 μsec/cm with horizontal amplifier and trigger providing 10 X expansion to 400kc. Five plug-in amplifiers, ranging in price from $80 to $160, give the unit broad operating capabilities: 23 nanosecond rise time; sensitivities of 100mv/cm with 15mc bandwidth and ±5% accuracy. Narrow band and wide band differential amplification as well as tuned bandwidth to 32mc are also available.

There are two models in the 43 Series—the Single beam S43 at $365 and the Dual beam D43 at $399. Each instrument is fully guaranteed for one year, and complete servicing is provided.

If you don't need a status symbol but do require performance and reliability in the essentials, the S43 is the finest scope available. And at $365 it is very available.

Data Instruments Div. • 7300 Crescent Blvd. • Pennsauken, N.J.

data instruments

did

UNDERWATER TV

A complete underwater TV system workable down to 1300 ft. in fresh or salt water developed by Cohu Electronics, Inc., includes Cohu 2000 series miniature TV camera (above), 12" long, 3" wide, with special underwater housing. Camera has fixed-focus half-inch lens with remote focus control, plus standard vidicon. Attached is mercury vapor lamp (400w.) that can stand 5000 psi.

"LONGEST ANTENNA" ERECTED AT ANTARCTICA BASE

U. S. engineers have built the world's longest antenna—a 21-mile wire laid out on Antarctica's icecap. It will be used solely for scientific study.

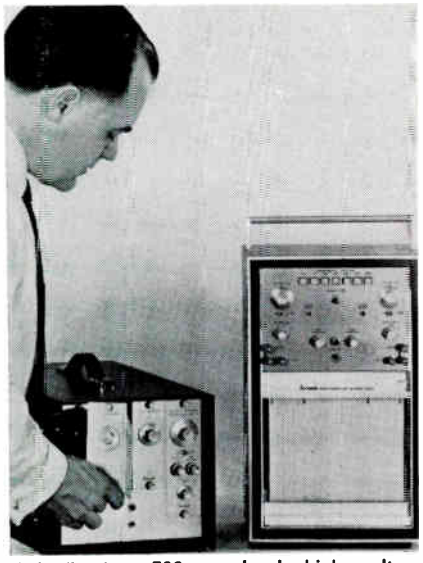
University of Washington engineers strung the three-quarter inch cable on the snow about 900 miles from the South Pole near Byrd Station, major U. S. radio research base in Antarctica. The plastic-coated copper wire was laid on top of ice estimated at one and one-half miles deep, about the same as stringing an antenna the same height anywhere else above the earth.

Studies were made of the transmission properties of the long antenna which radiates VLF. Later on investigators will use the antenna to try to duplicate certain lightning-produced VLF signals, called "whistlers" from sounds they make in receivers.

AFCEA PANEL DISCUSSION

"Recent Advances in Record Communications Systems" will be a panel subject presented by Western Telegraph Co., International Telephone and Telegraph Corp., and the UNIVAC Division of Sperry Rand Corp. at the 19th Annual Armed Forces Communications and Electronics Association Convention this spring. The Convention is to be held May 25, 26 and 27 at the Sheraton-Park Hotel in Washington, D. C. The panel is scheduled for Wednesday morning, May 26.

HV PREAMPLIFIER



Full - floating, 500 μv. level, high - voltage dc preamplifier that accepts microvolt level signals up to 1000v off - ground on low - level channel, or a potential difference up to 1000v dc. on high level has been developed by Brush Instruments, Clevite Corp. Amplifier, recorder and system monitored are all protected by current limiters and over - voltage devices. Unit insures noise-free operation.

FEDERAL GRANTS TO AID PRIVATE OPTICS RESEARCH

A program by the Advanced Research Projects Agency allows one-time grants for optics equipment for institutions engaged in optics research programs for the Department of Defense.

The grants will help to strengthen the optics programs of colleges and universities by providing funds to update research equipment used on DOD programs, and also provide the most recent equipment for graduate study.

As defined by DOD, modern optics includes: geometrical and physical optics, electromagnetic waves, coherence phenomena, statistical optics, and quantum optics. Schools and laboratories selected for such grants will receive them in 1965.

CONVENTION PAPERS

The 1965 IEEE International Convention held in New York City March 22-26, had a substantially larger program than in previous years. More than 350 technical papers were presented, revealing a host of important advances in every branch of the electrical and electronics field. The 1965 IEEE International Convention Record will contain all available papers presented at the Convention. It will total nearly 3,000 pages and will be issued in 13 parts.

INJURED SCIENTIST URGES ELECTRONIC HIGHWAY SYSTEM

An accident-conscious woman scientist suggests a solution to the growing traffic nightmare — a computer-controlled traffic monitor system for future super-highways.

Dr. Edith M. Bairdain, senior systems analyst at ITT Data and Information Systems Division, recovering from an auto mishap, sees a national network with a "brain center" linked to devices at entrances, exits and toll points. Display equipment would be along routes, at access approaches, at control headquarters, and toll booths, all manned by trained personnel. The system would include "eyes" that scan and verify registration and licenses. One guard might monitor eight lanes of traffic at one point. System might even include a billing system to do away with money exchange at booths.

Display systems, including possible video in personal cars, would relay up-to-minute data on road conditions, weather, and accidents to check points and to drivers. Dr. Bairdain said an essential feature of display systems would be their ability to respond quickly to changing conditions.

The proposed system, according to Dr. Bairdain, a take-off of techniques now used in space and military systems, is well within the reach of current technology.

MICROCIRCUITRY PRINTER

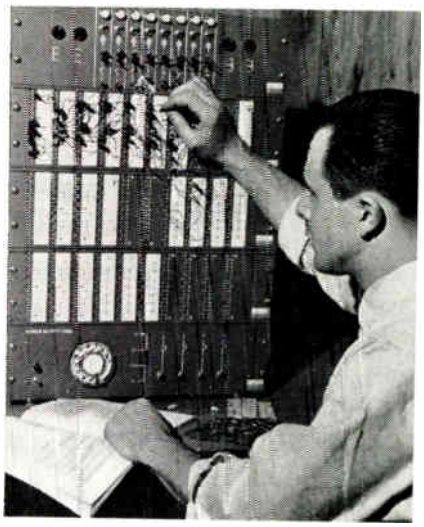
An automatic line drawing machine that simplifies output of tiny electronic circuits has been unveiled by National Cash Register Co., in conjunction with Air Force Avionics Laboratory.

With the new device, according to NCR, the whole photo reduction mask-making process can be side stepped. A tiny dot of light, focused on the final master photoplate, traces the image, or circuit map on the plate as the plate is moved around in small increments through coded instruction.

MARINER ANTENNA

Data from Mariner IV enroute to Mars is being beamed to earth by a new antenna, one of the lightest yet strongest structures ever fabricated by man, reports Whittaker Corp. Total weight of the elliptical, parabolic antenna, including support structure, is 3.02 lbs., less than the weight of a standard telephone. Of that total weight the reflecting surface, measuring 46 x 21 in., weighs only 1.1 lbs.

DIGITAL LAB SYSTEM



Desk-top Digital Laboratory System introduced by Digital Equipment Corp., is described as versatile digital-logic training device and design tool. It allows student or designer to build an operating system, complete with logic elements, power supply, controls, indicators and mounting hardware.

ENGINEER SOCIETY PUBLISHES PRIVATE PRACTICE ROSTER

A 420-page "Roster of Professional Engineers in Private Practice," has been published by the National Society of Professional Engineers.

The first of three sections of the roster includes names, addresses, firms and primary engineering fields. Section two covers, by state, firms with which individuals are associated. Included are addresses of offices and branches, size of firms, principals, and brief work descriptions. Section three lists 96 fields of engineering and the firms with proficiency in those fields.

Copies may be secured from Professional Engineers in Private Practice, National Society of Professional Engineers, 2029 K Street, N.W., Washing, D. C., 20006. Price to members: $5.00; to nonmembers it is $10.00.

RF POWER TRANSISTOR

An ultra-high reliability version of the RCA 2N3375 overlay power transistor, "tailored for aerospace, military and high-reliability industrial applications," is now available, reports RCA Electronic Components and Devices.

The device, numbered RCA 40279, is an epitaxial silicon n-p-n planar transistor intended for Class A, B, or C amplifier, frequency multiplier, or oscillator operation. It is planned for "off-shelf" supply, and should find use in transmitters needing up to 7.5w. output at 100MC and 3w. at 400MC.

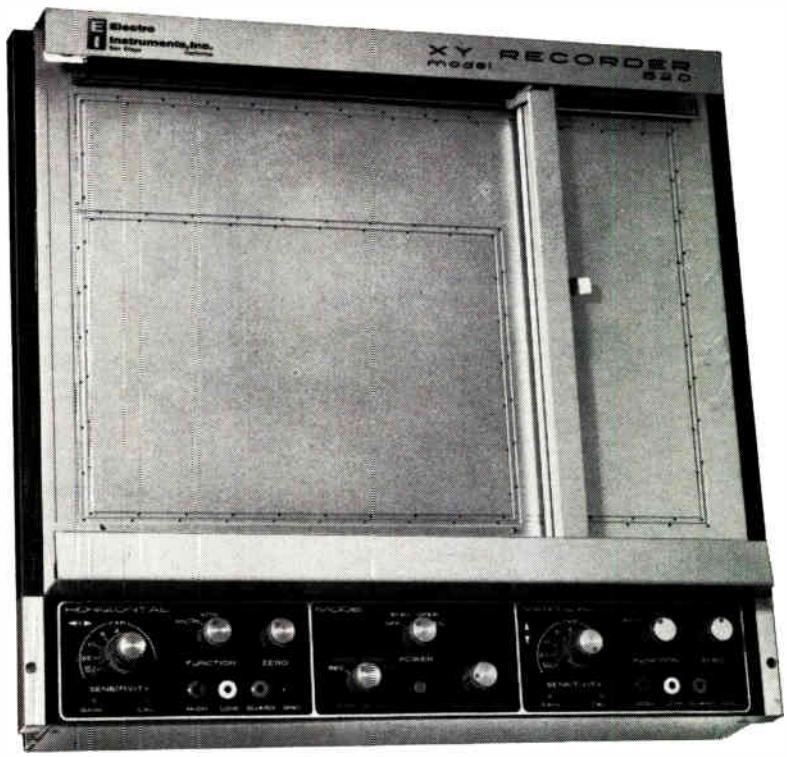
COMPARE!

THESE 9 MAJOR FEATURES OF

MODEL 520 X-Y RECORDER

FROM
ELECTRO INSTRUMENTS
THAT MAKE IT

THE WORLD'S MOST PRACTICAL



TRUE DIFFERENTIAL INPUT—permits measurements from grounded or ungrounded sources.

HIGH SENSITIVITY—to 100 microvolts per inch . . . eliminates need for preamplification.

HIGH INPUT IMPEDANCE—from potentiometric in millivolt ranges to 10 megohms . . . prevents source loading.

TIME BASE—on both axes . . . for maximum flexibility.

QUIET VACUUM HOLDDOWN—holds paper securely, does not attract dust, contaminates.

TABLE OR RACK MOUNTING—without need for modification kits or adapters.

SINGLE SWING-OUT CIRCUIT BOARD—for easier maintenance, eliminating problems caused by plug-in circuit board connectors.

BUILT-IN EVENT MARKER—for event time recording on both axes.

REAR INPUTS AND REMOTE OPERATION—at no additional cost. Priced Only **$2095**

Electro Instruments, Inc.
8611 Balboa Avenue, San Diego, California 92112
Electro International, Inc., Annapolis, Md.
Electro Instruments s. a., 512 rue de Geneve, Brussels 3, Belgium

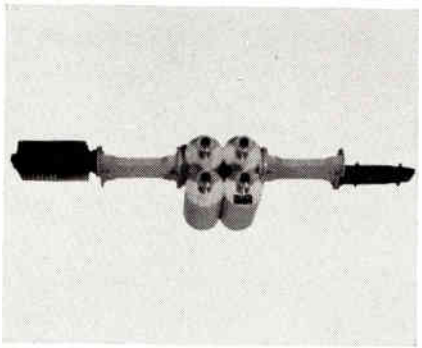
Circle 91 on Inquiry Card

NEW PRODUCTS

". . . advancing the STATE-OF-THE-ART in Components & Equipment.

BAND PASS FILTER

Permits only principal portion of fundamental freq. to be transmitted.



Model S4798B high-power band-pass filter is suited for radar uses where r-f interference is a problem. By preventing unwanted spurious emissions, it effectively eliminates any possible interference with neighboring radar systems. The filter displays a bandwidth ratio of less than 6 to 1 @ 60db. Freq. range is 2700-2900MC and ripple is 0.3db max. Power capability is 1.2 megawatts peak, 4.2kw average. VSWR is 1.4:1 max. Aircraft Armaments, Inc., Cockeysville, Md.

Circle 200 on Inquiry Card

PULSE GENERATOR

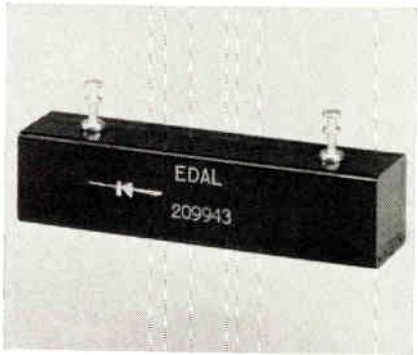
Produces a flat-topped 100KC pulse with rise time below 1nsec.

The Model 8000A pulser is used for measuring the response of fast semiconductor transit times. The pulser's 10v. output is an essentially flat-topped pulse with a repetition rate of 100KC and rise time below 1nsec. Overshoot and pulse top variations are held to less than 2%; the flat top is maintained for at least 100nsec., and fall time is less than 20nsec. The trigger output is of a fixed negative polarity. It is advanced 200nsec.; has rise time less than 6nsec.; width 20nsec.; and amplitude 0.5v. into 50Ω. Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.

Circle 201 on Inquiry Card

MULTIPLE CIRCUIT

Offer many optional configurations in one standard modular design.

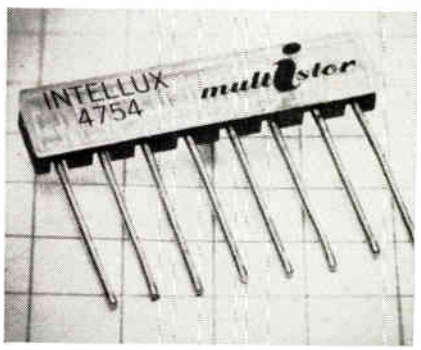


The Series N cold case silicon packages eliminate soldering many diodes to achieve equivalent circuitry. Available in full-wave, half-wave, doubler, center tap, open bridge and 3 phase types. Units consist of matched, pre-tested, pre-selected, double diffused avalanche rectifiers, self-protected against voltage transients. Standard types offer voltage ratings from 1500 to 30Kv PIV, with currents from 20ma to 6a. Edal Industries, Inc., 4 Short Beach Rd., East Haven, Conn.

Circle 202 on Inquiry Card

RESISTOR NETWORKS

Thin-film passive device. Resistivity range is 40 to 120Ω/sq.

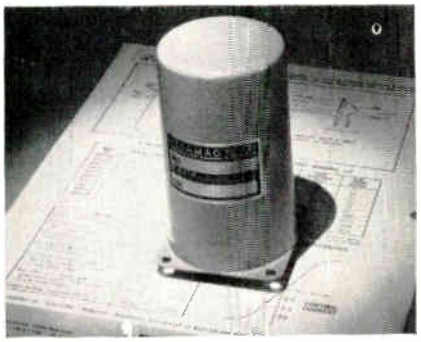


With the Multistor line, tin oxide is deposited on a high resistivity glass substrate, photo etched, terminated with fired ceramic silver, and hermetically sealed with a fused glass superstrate. Individual resistors are interconnected with an electroplated copper cross-over pattern. It can provide a network with precisely controlled temp. coefficient tracking, negligible interelement capacitance, and low noise. Tolerances are 10, 5, and 2½%. Multistors meet performance of Mil-R-10509D and are available with minimal lead time. Intellux Inc., Santa Barbara, Calif.

Circle 203 on Inquiry Card

MAGNETIC AMPLIFIERS

Withstand 1000% overloads or can operate into dead short without damage.

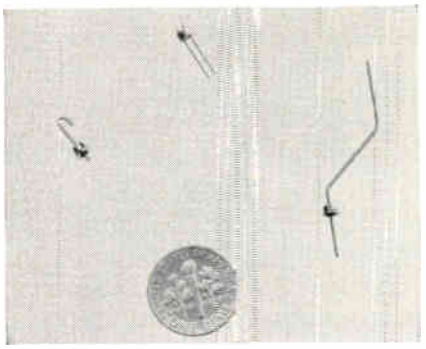


The Ultamag® 100 solid state magnetic amplifiers have high resistance to radiation. Available in either 50 or 60 CPS. They can be used in almost any application where vacuum tubes or transistors are required. Life is 10 yrs. The units provide up to 43db polarity reversible gain with 0 stability better than 1%. Power requirements are 115vac ±10%, 50 or 60 CPS. Military & Computer Electronics Corp., 900 N.E. 13th St., Ft. Lauderdale, Fla.

Circle 204 on Inquiry Card

NON-MAGNETIC SEAL

Needs no intermediate plating. Can be soldered using soft solder or flux.



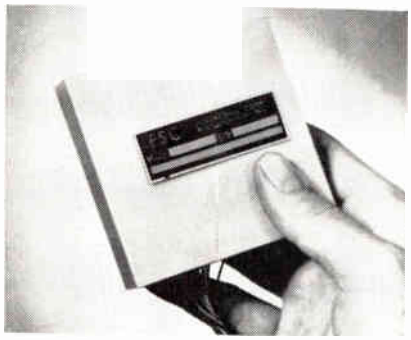
This new non-magnetic hermetic seal is made of stainless components and formulated glass. It requires no protective plating. Like all previously available non-magnetic seals, it can be silver brazed and resistance or heliarc welded, as required. It will withstand thermal shocks from 600°F to —320°F. Leak rate will not exceed 1 x 10^{-9} cc of helium/sec. Solderable non-magnetic seals are currently made in single and multi-terminal configurations, and meet all applicable Mil specs. Very close dimensional tolerances can be held. Harrison Seal Corp., 100 Sylvan Ave., Newark, N. J.

Circle 205 on Inquiry Card

NEW PRODUCTS

TRANSPONDER DELAY LINES

Has a delay to rise time ratio of 50:1 for a 10.5μsec. delay.

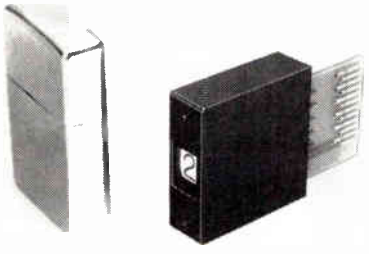


Model 4671 is enclosed in a 2¾ x 3 x ½ in. silicon rubber package. Taps are provided to a tolerance of ±0.05μsec.; the delay impedance is 750Ω, and pulse attenuation is less than 40%. The package contains 2 additional delay lines with 1.15 and 1.4μsec. delays. Impedance for these 2 sections is also 750Ω and the pulse rise time for each is 0.2μsec. The package can be molded to a PC board. Its operating temp. range is −55°C to +105°C. ESC Electronics Corp., 534 Bergen Blvd., Palisades Park, N. J.

Circle 206 on Inquiry Card

PULSE DRIVEN DISPLAY

Indicates numerals from 0 to 9 with a response time of 450msec.

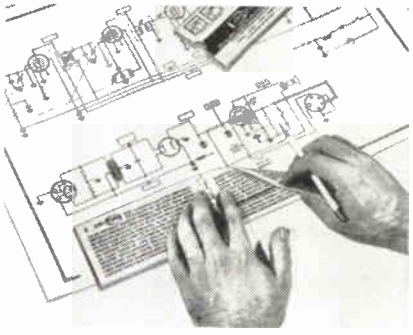


The Logicator has only 1 moving part, the indicator wheel. The module is actuated by an 11 wire input through a PC card in the rear of the display. Female connectors are furnished, and solid-state drivers are available for various computer interfaces. All numeral positions are magnetically detented, eliminating electrical power between drive pulses. Minimum life is 25 million cycles. The Logicators can be stacked to provide any number of figures when parallel driven. Actuating voltage requirement is 24vdc, 2w./module during the actuating period only. Bowmar Instrument Corp., 8000 Bluffton Rd., Ft. Wayne, Ind.

Circle 207 on Inquiry Card

MARKING KIT

For marking control panels, drawings and schematics, PC boards, etc.



The Deca-Dry transfer lettering kit contains hundreds of frequently used titles, words, codes, letters and numerals. They are pre-printed on dry transfer sheets. Images may be transferred to any dry surface by rubbing the transfer sheet lightly with a pencil, burnishing tool or ball point pen. No protective fixatives or lacquers are needed. A special heat-resistant adhesive and cohesive ink prevent images from moving, peeling, cracking or bubbling in hot reproduction. Chart-Pak, Inc., One River Rd., Leeds, Mass.

Circle 208 on Inquiry Card

BINDING POST

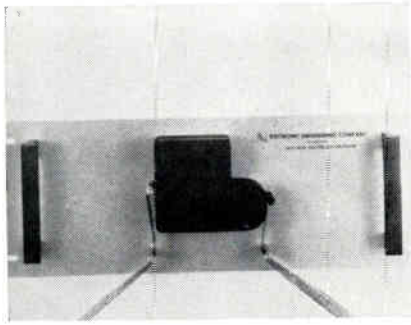
This 6-way post is rated at 40a., with a voltage breakdown of 7Kvdc.

The 111-300 series binding post has a tough, low-loss polyamide body which fully insulates the stud. A 6-way connection feature permits electrical connection by means of: banana plug; alligator clip to stud; wire wrapped around stud and clamped; wire (up to and including No. 10) through the center hole and clamped; clamped spade lug; and pin plug through the center hole and clamped. The post is furnished with a single ½-20 mounting nut; no auxiliary mounting hardware is needed. Insulation resistance of the post is greater than 200 megohms after Mil-T-5422B humidity test. E. F. Johnson Co., Waseca, Minn.

Circle 209 on Inquiry Card

BLOCK TAPE READERS

Reads 20 eight-bit characters at a time in parallel from 1 in. tape.



The EECO 5000 Photoblock Readers can control any automated punched tape programmed system. Typical uses include automatic test equipment, ground support systems, machine tool control, and manufacturing process control. Each signal output is capable of switching up to 100ma from either plus or minus logic levels, or from relay loads depending upon output option selected. The unit has no clutch, brake or pinch rollers. Electronic Engineering Co. of Calif., 1601 W. Chestnut Ave., Santa Ana, Calif.

Circle 210 on Inquiry Card

PULSE GENERATOR

Solid state pulse unit has a rise time of less than 200psec.

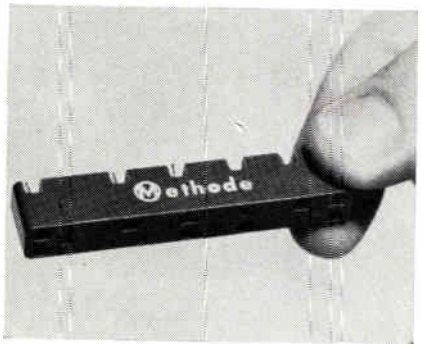
Output pulse amplitude of Model 125 is a fixed negative 10v. into 50Ω, with pulse top distortion of less than 5% p-p from ideal waveform. Pulse width is continuously variable from 700psec. to 100μsec. A fine control and 1/3/10 coarse selector provide continuous pulse width coverage. Width jitter is approx. 0.1%. Rep. rates from 10 CPS to 3MC, continuously variable. Unit is useful in high signal-to-noise measurements needed for time domain reflectometry uses. It also has uses in development, production and testing of diodes, cables, transformers, delay lines and video amplifiers. E-H Research Laboratories, Inc., Oakland, Calif.

Circle 211 on Inquiry Card

NEW PRODUCTS

BUSSING CONNECTOR

Mounts on any PC board up to 3/32 in. thick; can be dip or wave soldered.

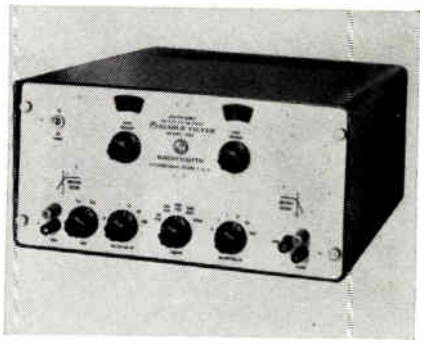


Model TB-809 WS is a 9-contact bussing connector. It is expected to be used in communications, data acquisition and transmission equipment. The connector mounts through 0.051 dia. holes. Jumper bars are available for bussing between any pair of contacts. Insulation is glass-filled diallyl phthalate. Connector measures 2⅜ x 0.340 x 7/16 in., not including terminals. Methode Electronics, Inc., 7447 W. Wilson Ave., Chicago, Ill.

Circle 212 on Inquiry Card

VARIABLE FILTER

Provides low-pass, high-pass, band-pass, and band reject operation.

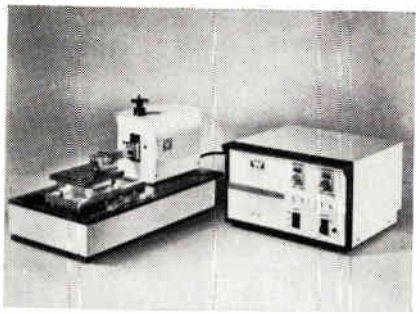


Model 335 has high and low cut-off freqs. independently adjustable from 0.02 CPS to 20KC. Applications include vibration studies, geophysical or seismological instrumentation, use with 1-f measurements requiring selective amplification, plus use in electromedical research, psychoacoustics, and the freq. analysis of audio instruments and transducers. Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge, Mass.

Circle 214 on Inquiry Card

FLAT PACK WELDER

For high-speed welding of integrated circuit flat packs to PC boards.



The Autobond welder can be programmed to make up to 300 welds/min. Modular in design, it consists of 3 basic units: motor-driven X-Y positioning table, all solid-state power supply, and digital readout welding head. The positioning table guides a PC board containing the parts to be welded through a preset course under a pair of wheel electrodes. The power supply is fired each time the welding program calls for a weld. After welding the table stops, allowing the finished piece to be removed. The power supply has dual-sensing circuits which control voltage amplitude and adjusts pulse duration during the weld cycle. Weldmatic Div./Unitek, 950 Royal Oaks Dr., Monrovia, Calif.

Circle 213 on Inquiry Card

IMPEDANCE METER

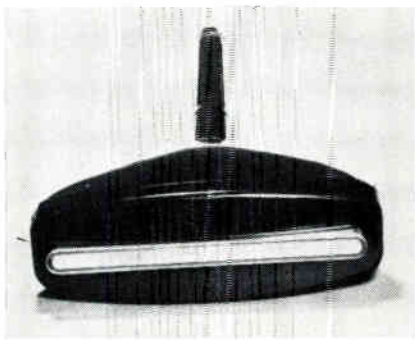
Provides direct reading impedance measurements from 5 CPS to 500KC.

Vector Impedance Meter Type 4800A is self-contained. Impedance magnitude from 1Ω to 10 megohms and phase angle from 0 to 360° is instantaneously displayed on 2 front panel meters. Analog outputs directly proportional to impedance magnitude, phase angle, and freq. are also available. Thus, by a single connection to an X-Y recorder direct reading plots of vector impedance as a function of freq. may be obtained. These outputs can actuate limit switches, or operate digital or expanded scale voltmeters for special uses. The instrument also functions as a direct reading L-C meter. It covers ranges from 1μh to 100,000 henries and 0.1pf to 10Kμf, respectively. Boonton Radio Co., Green Pond Rd., Rockaway, N. J.

Circle 215 on Inquiry Card

FIBER OPTIC CRT

Fiber optics strip is in the faceplate. For high resolution photographic recording.

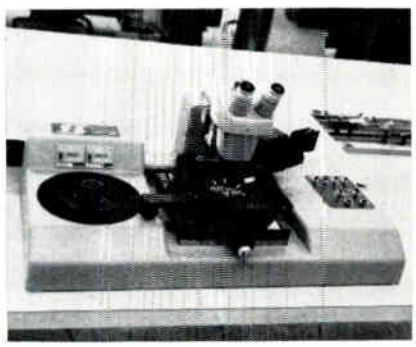


The SC-3800 is designed for grounded anode voltage circuit uses only. The fiber optics strip has an approx. active area 8½ in. long x 5/16 in. wide. The electron optical system and fine grain screen achieve a very fine trace width using conventional focusing and deflection units. Electronic Tube Div., Sylvania Electric Products Inc., Seneca Falls, N. Y.

Circle 216 on Inquiry Card

WAFER TESTER

For testing transistors or integrated circuits in wafer form.



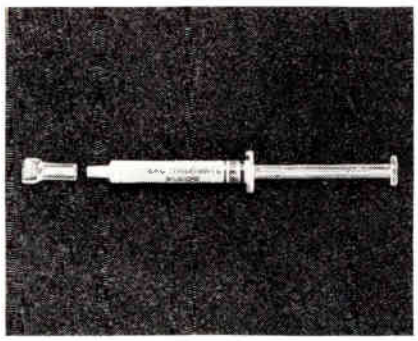
The Waferprobe Mk III is adjustable to any device pattern. It probes up to 15 contact areas at once, then sequentially marks, records, and steps to the next pattern. Mechanical accuracy and sensitivity has been increased by using a double-acting 30-to-1 reduction manipulator. This ace-in feature gives the operator an almost instantaneous compensating response. This prevents losses due to slight stepping misalignment. The vacuum-chuck stage offers variable stepping between 12 and 320 mils. It covers wafers up to 1½ in. dia., and tolerates a thickness variation of 3 mils within a wafer. The easily set probe points span a circular region 187 mils in dia. Each point is independently adjustable in a 93-mil sq. subregion. Siliconix Inc., 1140 W. Evelyn Ave., Sunnyvale, Calif.

Circle 217 on Inquiry Card

NEW PRODUCTS

HEAT SINK COMPOUND

Exact amount of the compound can be speedily placed in a precise area.

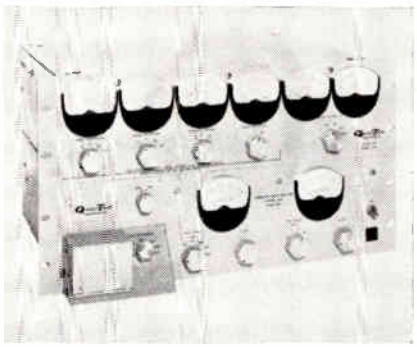


Ther-Mate is a compound of improved silicone grease. It is contained in a dispenser. In use, the dispenser provides easy application to thermal interfaces such as mounting a transistor to a heat sink. The compound is heavily loaded with metal oxides to increase thermal conductivity. It will not harden, soften or run within a temp. range of —65 to 200°C in continuous use. International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif.

Circle 218 on Inquiry Card

NOISE ANALYZER

Measures transistor noise. Used for FETs and standard junction types.

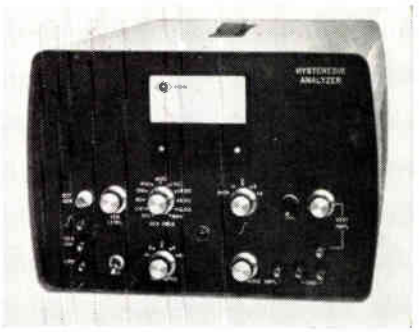


Model 2173 control unit combined with model 2181 filter unit measures transistor noise at collector currents from 0.3μa to 30ma, and collector voltages up to 60v. simultaneously. It operates at 5 freqs. between 10 CPS and 100KC. The 2173 control unit provides collector and bias power and controls for the transistor under test. It contains the transistor test jig, preamplifier, and automatic calibration circuits. The 2181 filter unit contains 5 separate filter channels and attenuators. Noise voltage spectral density can be read simultaneously at 5 different freqs.: 10 and 100 cycles, 1, 10 and 100KC. Quan-Tech Laboratories, 43 Jefferson Rd., Whippany, N. J.

Circle 219 on Inquiry Card

HYSTERESIS ANALYZER

For the measurement of hysteresis of 2-terminal, non-linear networks.

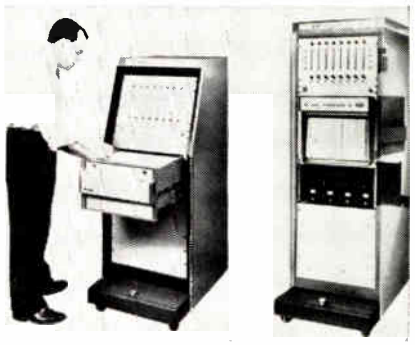


This solid-state unit consistently portrays 5 different parameters on visual hysteresis plots, plus 3 additional measurements which can be calculated. It offers integration ratios from 10:1 to 10^6:1 and an integration amplification of 50db gain to each axis. Range is 50 CPS to 50KC; noise and hum level is 50μv. Power output is 50w.; power input is from 105 to 125v. RMS at 150 CPS to 400 CPS. Emco Systems Inc., 922 S. Lyon Ave., Santa Ana, Calif.

Circle 220 on Inquiry Card

D-W OSCILLOGRAPHS

Modular concept permits makeup of hundreds of multi-channel systems.

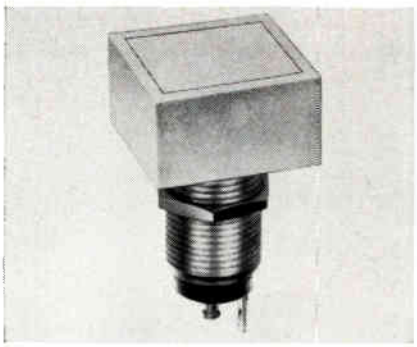


With the Mark 200 Series 1707 units, hundreds of recording system configurations can be made up from all-solid-state subsystems. The unit can be arranged to suit the specific needs of any application in laboratory, production, aerospace and medical research. Wide flexibility is offered by combining modules and a unique cabling setup for interconnecting them. A positive keying arrangement insures that subsystems are properly connected. Overall system accuracy of any combination of subsystems can be as high as 0.5%. Chart speeds in 12 steps are electrically controlled by pushbuttons. Brush Instruments, div. of Clevite Corp., 37th & Perkins, Cleveland, Ohio.

Circle 221 on Inquiry Card

SQUARE LENS LAMPHOLDER

Lamps can be replaced from front by removing lens. Available in 4 colors.

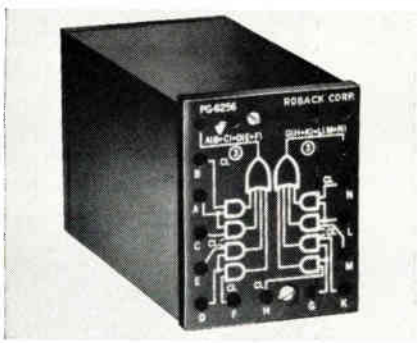


The Contempo 300 Series Square Lens indicator lights are two terminal devices. Series 301 features a ¾ in. sq. lens, and mounts in a 7/16 in. dia. hole. It is 1-11/32 in. long. Unique feature of this series is its "push-pull" lens. The lens is "pulled" to remove, and "pushed" to install. Lens colors available are red, white, blue, green, and amber. The Sloan Co., P. O. Box 367, Sun Valley, Calif.

Circle 222 on Inquiry Card

BREADBOARD MODULE

Plug-in combines logic function of A (B + C) + D (E + F) in a single package.



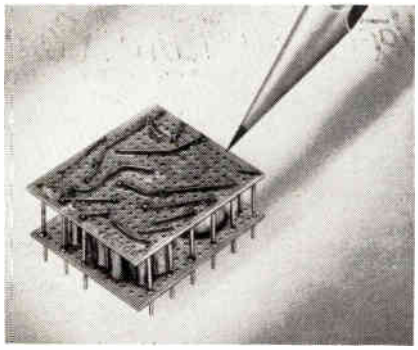
Pulse gate PG-6256 provides a nominal 1½μsec. positive pulse output when any of 4 input clock lines are triggered with a 1 level. Two separate gate lines provide an AND/OR function between the 4 gate inputs. Four standard loads may be driven from the output. The new module can be wired on the front or on the back. A diagram screened on its front indicates logical function. An integral front-panel light indicates logical state of the circuit at a glance. Power and ground connections are made when the module is plugged into the breadboard frame. Thirty-three modules can be accommodated in a 7 x 19 in. frame. Up to 330 4-circuit modules or a total of 1320 circuits can be breadboarded in a single 6-foot relay rack. The Roback Corp., H-K Module Div., Huntingdon Valley, Pa.

Circle 223 on Inquiry Card

NEW PRODUCTS

INSULATING BOARD

Mounts integrated circuits and discrete components when building prototypes.

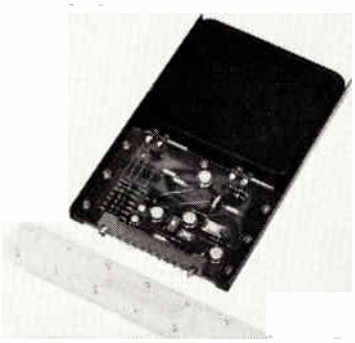


The Micro-Vectorboard™ is a pre-punched, epoxy glass insulating board with closely spaced, small hole patterns. It may be used with microminiature components and modules. Miniature push-in terminals, plug pins, high density plugs and receptacles are also available. The board is especially useful as a holding matrix when making cordwood modules. Small grid patterns and miniature push-in terminal and plug pins allow high component density. Vector Electronic Co. Inc., 1100 Flower St., Glendale 1, Calif.

Circle 224 on Inquiry Card

INTEGRATED MEMORIES

High volume-per-bit configurations accomplished by integrated circuits.

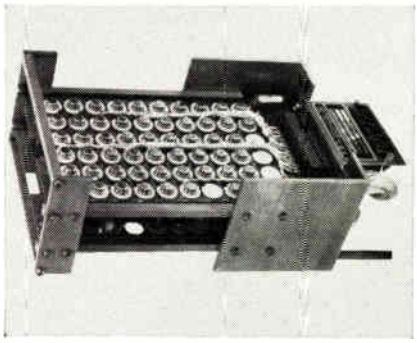


This magnetostrictive delay line memory system has recirculation and interface electronics. It is used for serial systems operating at clock rates to 2MC (glass line systems are available for clock rates to 20MC). Dimensions of the illustrated unit are 4 x 6 x ½ in. Storage capacity is 1,024 bits or nearly 100 bits/cu. in. It qualifies to Mil-E-5400 for reliable operation from −55°C to +125°C. The system consumes ½w. Logic levels are 0 and +3v. at the interface. Various operating voltages and other logic levels can be accommodated. Digital Devices Inc., 212 Michael Dr., Syosset, L. I., N. Y.

Circle 225 on Inquiry Card

CHARACTER GENERATOR

Approx. 80 integrated circuits, 6 transistors, and discrete components are used.

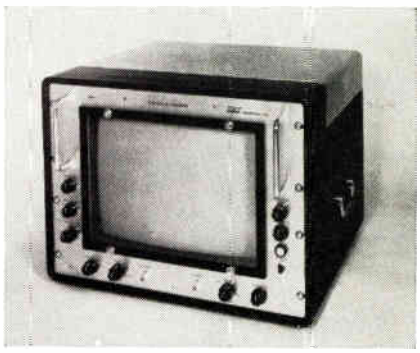


The type CLX33083 integrated circuit alphanumeric character generator is packaged on two 8 x 4¾ in. plug-in. circuit boards. It generates all digits, all letters (except the Q and Z) and 4 special symbols. The inegrated circuit unit operates at rates up to 50,000 characters/sec. A crystal-controlled clock allows the unit to be used as a clock source for other equipment, in addition to performing the nominal function of character generation. Information Displays, Inc., 102 E. Sandford Blvd., Mt. Vernon, N. Y.

Circle 226 on Inquiry Card

DATA DISPLAY

Simultaneously shows 5 displays on a single-gun 17 in. CRT.



The Skan-A-Scope contains its own power supply and is used with a sweep generator. It can simultaneously display 3 traces plus 2 reference lines; 2 traces plus 3 reference lines; or 1 trace plus 4 reference lines. The traces may be shown in separate positions along the Y axis or may be superimposed. Birdy or pulse-type markers, which appear as vertical lines (electronic graticules), may also be displayed. Two standard waveforms can be displayed to provide upper and lower limits of a waveform. It can monitor 3 inputs simultaneously from 3 remote locations. Telonic Industries, Inc., 60 N. First Ave., Beech Grove, Ind.

Circle 227 on Inquiry Card

FREQUENCY CHANGER

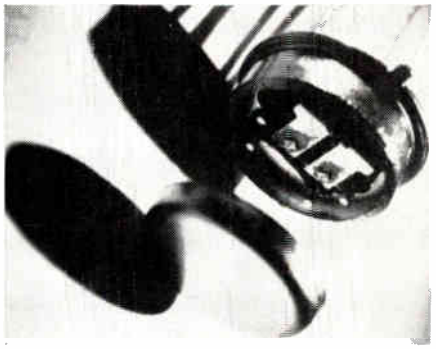
Supplies 50/60 CPS ac from non-standard ac. Uses a rotary converter and SDR.

The Change-A-Cycle device uses a principle entirely different from conventional motor-generator devices. The ac input (from 25 to 400 CPS) is first rectified to dc. It is then filtered and fed to a rotary dc to ac converter which, in turn, produces either 50 or 60 CPS current. Standard units operate from single phase input and deliver single phase output. Units are available with up to 2kw outputs. Carter Motor Co., 2760A W. George St., Chicago, Ill.

Circle 228 on Inquiry Card

PNP TRANSISTORS

Device contains 2 isolated high-gain low-noise transistors.



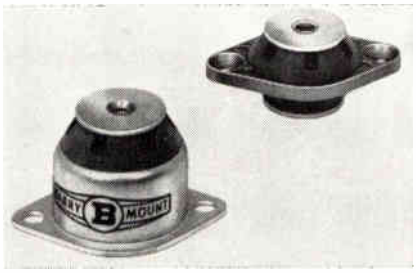
The 2N3727 6-terminal device contains 2 isolated high-gain, low-noise pnp double-diffused transistors in 1 hermetically sealed enclosure. The silicon planar epitaxial device may be used in high performance amplifier and differential amplifier circuits operating at low current levels. Matching characteristics include h_{FE} ratio of 0.90 to 1.0; V_{BE} differential less than 2.5mv. Max. operating junction temp. is 200°C. DC current gains at various minimums are: min. 80: $I_C = 10\mu a$; $V_{CE} = -5v.$; min. 120: $I_C = 100\mu a$; $V_{CE} = -5v.$; min. 135: $I_C = 1.0ma$; $V_{CE} = -5v.$ Fairchild Semiconductor div. of Fairchild Camera & Instrument Corp., 313 Fairchild Dr., Mountain View, Calif.

Circle 229 on Inquiry Card

NEW PRODUCTS

VIBRATION ISOLATORS

Provides equal protection in all attitudes from 35 CPS to 2000 CPS and higher.



The E21 and E22 are small, lightweight, and ideally suited for protecting electronic equipment wherever space and weight is at a premium. The isolators may be loaded in compression, tension, or shear. Interlocking metal parts, plus elastomer-in-compression design, provide fail-safe construction and eliminate bond failure problems. Resonant transmissibility is less than 3.5. Three different load ranges are available as standards to handle loads from 4.50 to 20 lbs./isolator. Barry Controls, 700 Pleasant St., Watertown, Mass.

Circle 230 on Inquiry Card

CONNECTOR/RECEPTACLE

Minimizes noise, eliminates shorts, and assures positive connection.

The ST-34 compact 4-pin molded flexible-handle connector and mating receptacle is less than 2⅛ in. overall. A special D shape insert makes incorrect insertions impossible, while a positive screw-type lock ring guards against accidental disconnects. The ST-34 accepts cables up to 7/32 in. O.D. and is available on special order in 2 and 3-pin types. Switchcraft, 5555 N. Elston Ave., Chicago, Ill.

Circle 231 on Inquiry Card

MINIATURE FUSEHOLDERS

Accept ¼ x 1¼ in. fuses. Require ½ in. mounting holes and are 1⅝ in. long.

Two fuseholders have been developed for compact panel mounting. One holder has a knob for easy gripping even with gloves. The other is equipped with a screwdriver slot for removing the knob. The fuseholders are molded of phenolic, and withstand severe vibration, shock and other environmental conditions. Current carrying capacity: 30a. for any voltage up to 250. These fuseholders are available with quick-connect terminals, if desired. The fuseholders extend 29/32 in. behind panel front. Bussman Mfg. Div., McGraw-Edison Co., St. Louis, Mo.

Circle 232 on Inquiry Card

MULTIPLE POT/SWITCH

Offers high accuracy phasing between elements, simpler system set-up and checkout.

The Model 8P50 has 2 conductive plastic resistance elements of standard ±0.5% linearity. An SPDT switch can break at least 100ma at 30v. The switch wipers are phasable to better than 0.005 in. to obtain the desired relationship between the 2 switching positions and the resistance element wipers. Phasing of the 2 elements is held to 0.001 in. The 0.4 in. stroke unit can be specified with resistances from 100Ω to 20KΩ, and to special accuracy of ±0.3%. Markite Corp., 155 Waverly Place, New York, N. Y.

Circle 233 on Inquiry Card

MICA CAPACITORS

Standard units are supplied with B characteristic and ±5% capacitive tolerance.

The types 271 to 273 and 291 to 294 mica transmitting capacitors are encapsulated in a thermosetting compound. The new units are available in 7 sizes. The operating temp. range is −55°C to +125°C. Optional aluminum plates, conforming precisely with the mounting hole configurations of molded or ceramic case capacitors, simplify replacement. Sangamo Electric Co., Springfield, Ill.

Circle 234 on Inquiry Card

VARIABLE TRANSFORMERS

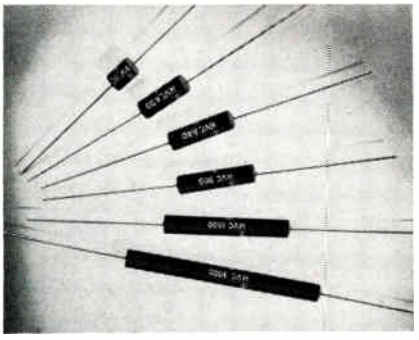
Ranges from 1 to 3a., of 120v. input, 0-120/132v. output variable transformers.

These low-power transformers offer new design features. An adjustable shaft makes it possible to extend the shaft from either end or to substitute a longer shaft. This increases the versatility of mounting and simplifies actuation of associated devices (switches, etc.) without special construction. A double flat on the shaft allows 180° repositioning of the knob. Snap-in design permits instant replacement and positive retention of the brush-contact assembly with oversize heat sink. Ohmite Mfg. Co., 3649 Howard St., Skokie, Ill.

Circle 235 on Inquiry Card

SILICON RECTIFIERS

Consists of 17 units ranging in peak inverse voltage rating from 1800 to 30kv.



These high voltage cartridge type silicon rectifiers have avalanche characteristics which provide built-in protection against transient overvoltages. Dc ma range from 250 to 50, depending on the voltage. Max. forward voltage drop at rated current ranges from 4v. for the smaller units to 50vdc for the largest type. Sarkes Tarzian Inc., Semiconductor Div., 415 College Ave., Bloomington, Ind.

Circle 236 on Inquiry Card

DC VOLTMETER

Has a 20,000Ω/v., large taut-band meter, and 11 highly-overlapping ranges.

The Model M-1 has circuit-loading accuracy of ±0.1%. The meter uses 0.1% metal-film multipliers, and has precise 54.50μa (±0.1%) current loading on all ranges. Two adjustments permit complete recalibration. Albionics, 10033 S.E. 95th Place, Renton, Wash.

Circle 237 on Inquiry Card

INTEGRATED FLAT PACK

Plug-in unit eliminates the need for multilayer boards and kovar PC boards.

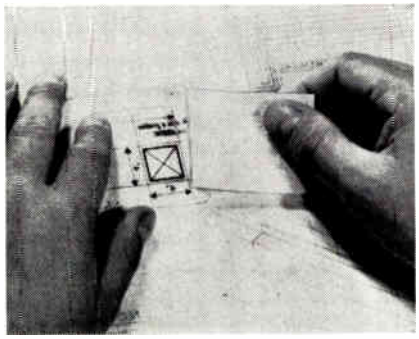
An integrated circuit flat-pack carrier is available for either ⅛ x ¼ x ¼ x ¼ microcircuits. It is available in 10 and 14 pin models. The circuits may be resistance welded, planar welded, or soldered. The pins mate with an economical pin socket which may be soldered into a PC board. Thus, the carrier may be permanently soldered into either the pin sockets or a mother PC board. Using pin sockets eliminates plated-through holes or eyelets, or kovar PC boards. The pin spacing permits most integrated circuit interconnections to be made on simple 2-sided PC boards, and exotic multi-layer boards are normally eliminated. Laboratory or field replacement of microcircuits can now be made without elaborate welding apparatus. Walkirt Co., 10321 S. LaCienega Blvd., Los Angeles, Calif.

Circle 238 on Inquiry Card

NEW PRODUCTS

LAMINATED SHEET

Backing sheet for symbols. Prevents moisture absorption.



This backing sheet will be used on all Stanpat preprinted repetitive symbols and drawing details. The backing sheet lays flat regardless of atmospheric conditions. It is transparent, allowing draftsmen to position the Stanpat before application to drawing. Without any change to the adhesive, both sides of the sheet are now sealed to prevent any absorption of moisture. Stanpat Products Inc., Whitestone, N. Y.

Circle 239 on Inquiry Card

POWER TERMINATION

Freq. range: 3.3 to 4.9GC; VSWR: 1.10 max.; average power: 25w. max.

These new medium power waveguide termination are available for use over the freq. range of 3.3 to 4.9GC in the normal microwave communication band. This standard medium power termination provides min. VSWR values over the entire waveguide operating freq. range within a min. length configuration. Flange is CMR-229. Waveline Inc., Caldwell, N. J.

Circle 240 on Inquiry Card

DIGITAL VOLTMETER

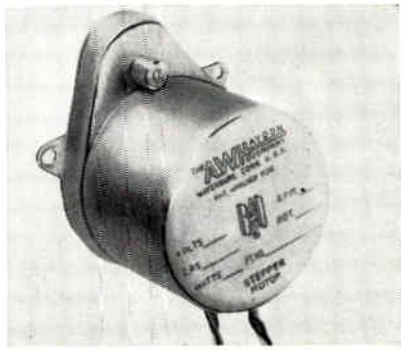
Measures voltages with an accuracy of 5 parts/million and a resolution of 1 ppm.

Model 2060 has a speed of 1.7 sec/reading. It can be used for rapid, automatic high accuracy testing and calibration of zener diodes; standard cells; voltage dividers; digital voltmeters and power supplies. It can also measure electrochemical potentials and resistivity in chemical, bio-chemical and materials research. Its range is 9.99999v. or 99.9999v. Input resistance is 100K megohms; digital output signals in 10-line decimal form operate digital recorders. Non-linear Systems, Inc., P. O. Box 728, Del Mar, Calif.

Circle 241 on Inquiry Card

STEPPER MOTOR

Develops 0.40 oz.-in. at the rotor with a max. power input of 12w.



Series 44600 rotation is unidirectional, either clockwise or counterclockwise, as required. The rotor shaft rotates in discrete 15° steps, and at rates up to 4800 steps/min. Positive magnetic detenting occurs at each of 24 angular rotor positions. Stepping action is obtained by applying dc pulses alternately to 2 stator coils. Operating voltage is 27vdc ±10° in standard models. The A. W. Haydon Co., 232 N. Elm St., Waterbury, Conn.

Circle 242 on Inquiry Card

HIGH-VELOCITY FAN

For high velocity air flow either inward or outward to cool equipment.

The Venturi-type delivers 420 CFM of push or pull cool air. The motor is 4-pole, shock-mounted, 115v., 50/60 CPS, single phase. The fan is extremely simple to install. No parts to assemble—just bolt the package to an opening and it is ready to operate. Overall dia. is 10½ in. McLean Engineering Laboratories, P. O. Box 228, Princeton, N. J.

Circle 243 on Inquiry Card

LEAD SPREADERS

For integrated circuits. Accommodate the 8, 10, and 12 lead TO-5 cases.

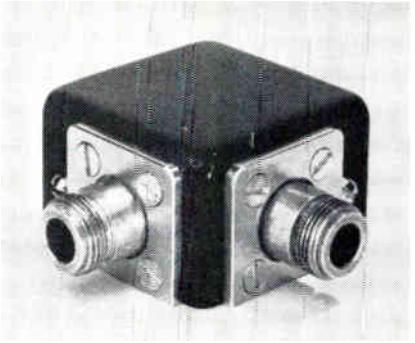
This new line of lead spreaders is available in 3 models: 7717-19 (8 lead); 7717-20 (12 lead); and 7717-21 (10 lead). Precision molded grooves guide the leads and spread them from a 0.200 dia. circle to a 0.400 dia. circle. This simplifies board fabrication and layout, and prevents costly solder bridges between leads. These lead spreaders use a unique keying feature. A slot in the rim locates the header tab and pin #1. This pin is not spread and can be visually identified. This provides positive keying and prevents accidental rotation during insertion. Thermalloy Co., 414 Exposition, Dallas, Tex.

Circle 244 on Inquiry Card

NEW PRODUCTS

S-BAND YIG LIMITER

For crystal protection and protection of tunnel diode amplifiers.

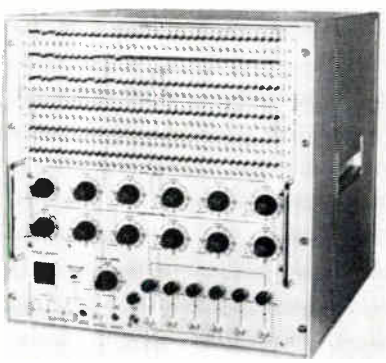


Model LS-101 Limiter has a limiting threshold of —10dbm. It can be provided either mechanically or electrically tuned over ±200MC centered at 2800MC. Complete AM suppression for modulation freqs. to 500KC is obtained over the entire bandwidth—a minimum of 20MC at limiting threshold. Unit allows selective limiting of signals separated in freq. by as little as 0.5MC. It has a 30db dynamic range and a 50KC/°C temp. coefficient. Physical Electronics Corp., 1185 O'Brien Dr., Menlo Park, Calif.

Circle 264 on Inquiry Card

DATA GENERATOR

Provides 6 channels of serially programmed pulse outputs in NRZ or RZ.



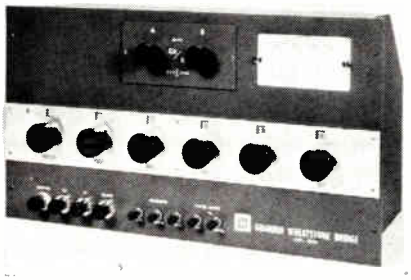
Model 206M features 72 bits/channel and independent delay, width, and amplitude for each channel. Auxiliary sync. pulses, clock pulse, and command functions allow test and evaluation of high speed tape and memory devices, and other multi-channel pulse equipment. Internal clock rate is continuously variable from 2 CPS to 2MC. It can be slaved to an external signal source. A single clock pulse is generated by pressing a front panel pushbutton. Sync. output is positive 6v. pulse approx. 50nsec. wide with 100Ω source impedance. Clock sync. occurs at the data rate. Datapulse Inc., 509 Hindry Ave., Inglewood, Calif.

Circle 265 on Inquiry Card

NEW PRODUCTS

WHEATSTONE BRIDGE

Measures resistances from 1Ω to 11K megohms. Readout in 6 figures.

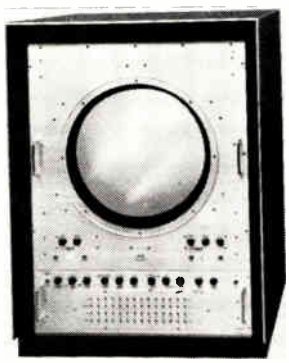


Model 4232-3B has guarded construction to eliminate leakage currents causing errors, and a dc reversal switch which allows a quick check of thermal emfs. Sensitivity is 0.001% from 10Ω to 10 megohms. Two rotary switches select bridge ratios, thus eliminating the twisting of tapered plugs previously used. Only the chosen ratio shows in the reading window to lessen the chance of misreading. To speed bridge set-up, an orientation card gives correct ratios and voltages for the unknown being measured. Leeds & Northrup Co., 4901 Stenton Ave., Phila., Pa.

Circle 247 on Inquiry Card

MULTI-CHANNEL OSCILLOSCOPE

Designed to display and store up to 56 data traces on the screen simultaneously.

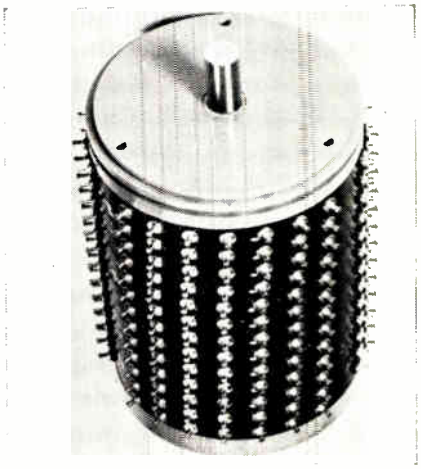


The VM-1S Visual Monitor has a freq. response from 5 to 300 CPS. Sensitivity is 2mv RMS/in. of deflection. Sweep speed is calibrated and continuously adjustable from 0.1 to 5 sec. An internal timing line generator traces vertical timing lines on the screen at 0.1 and 0.01 sec. Traces remain visible on the 21 in. dia. storage tube up to 10 min. or until erased. Automatic erasure occurs between sweep cycles, and the extent of erasure is adjustable. Sweep can be automatic or triggered from an external source. Applied Magnetics Corp., 749 Ward Dr., Santa Barbara, Calif.

Circle 248 on Inquiry Card

POTENTIOMETER

Multi-gang, 3½ in. long unit contains 260 tips (20 per 360°).



Model 205S contains 13 pot gangs. This film potentiometer functions as a precision voltage divider with multi-increment fixed voltage taps. The same pot can also be used to custom shape non-linear functions (experimentally) until the precise, desired function is obtained. With excitation applied to the wiper, it provides multiple gating signals. Terminal resistance is 120KΩ. Computer Instruments Corp., 92 Madison Ave., Hempstead, L. I., N. Y.

Circle 249 on Inquiry Card

RELAY BASES

Allows easy relay replacement in virtually inaccessible places.

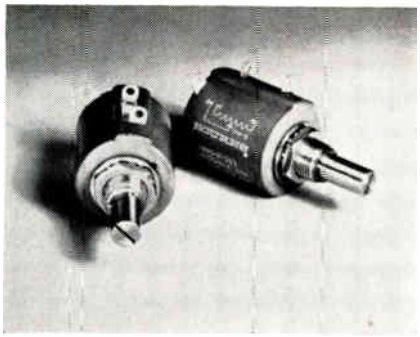
With this line of smooth contact environmentally sealed relay bases, polarization and contact alignment is made by using extended stud mounting hardware and an alignment pin built into the relay header. Sealing is provided by a resilient rubber grommet and a drawn aluminum compression cup. The grommet is permanently bonded to the nylon body of the receptacle. This provides pressure sealing of each wire, even if the compression cup isn't used in box mount applications. They meet military specs. controlling relay headers. Burndy Corp., Norwalk, Conn.

Circle 250 on Inquiry Card

NEW PRODUCTS

PRECISION POTENTIOMETER

Resistance values range from 50 to 500KΩ. Power rating is 2w. @ 70°C.

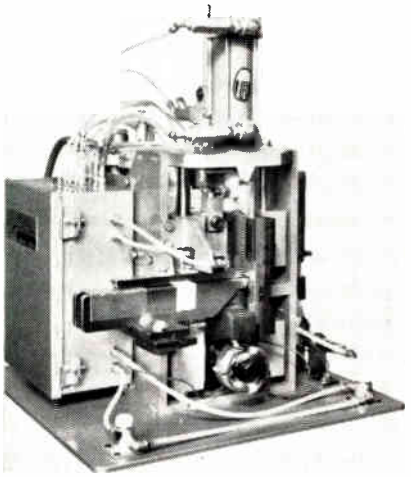


Model 3500 is ⅞ in. dia., bushing mount 10-turn unit. All-sealed construction ensures Mil-spec resistance to humidity. Silverweld® terminations, a fused bond between the terminal and resistance wire, eliminates fragile, single-wire termination. Resistance tolerance is ±3%; linearity is ±0.20%. Withstands vibration of 20G and shock of 100G. Bourns, Inc., 1200 Columbia Ave., Riverside, Calif.

Circle 251 on Inquiry Card

COIL SECURING MACHINE

Eliminates time consuming manual tying or taping methods of securing coils.

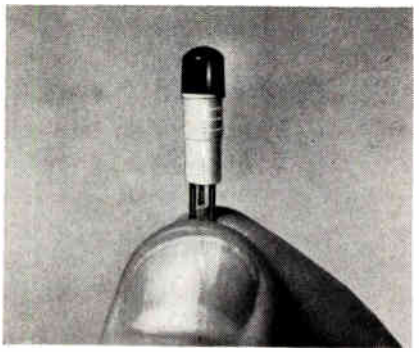


Model PCR-20 Automatic Coil Retainer Inserting Machine allows 1 operator to insert the coil retainer, stamp identifying numbers, secure the leads, and perform the final forming of the end turns at rates of up to 400 fields/hr. Designed for both machine wound and hand inserted fields, it handles stack dia. up to 6 in. and stack heights up to 3½ in. The standard machine uses preformed coil retainer material. Possis Machine Corp., 825 Rhode Island Ave. So., Minneapolis, Minn.

Circle 252 on Inquiry Card

MINIATURE INDICATOR LIGHT

Fcatures a subminiature relampable bulb and silicone epitaxial transistor.

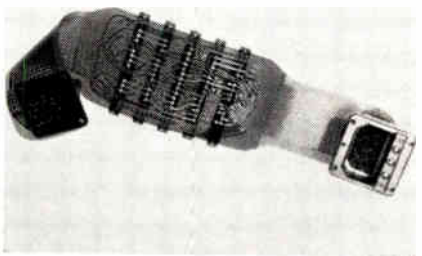


The transistor-driven Trans-Eye microminiature indicator light is designed for use with computer logic boards, high density control panels, instrument dials, airborne equipment, and electronic and electrical test equipment. It mounts without hardware by press-fitting into a 0.191 in. dia. panel hole, and extends less than ⅝ in. behind the front of the panel. It is designed for use with T-1 subminiature lamps with voltage ratings between 1.5 and 28v. and current ratings up to 125ma. Cal-Glo Co., 111 Eucalyptus Dr., El Segundo, Calif.

Circle 253 on Inquiry Card

CIRCUIT TECHNIQUE

Produces flexible multilayer circuits. Components may be wave or dip soldered.



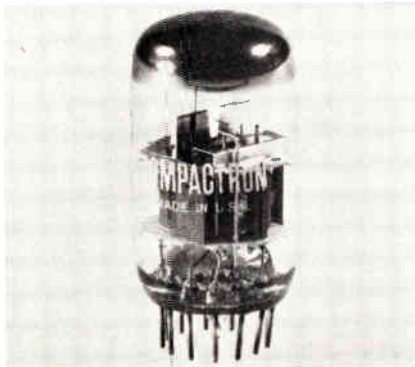
This new technique enables production of low cost, high density multilayer circuits. Solid copper post interconnection may be between any layers in a flexible and formable circuit assembly, or bonded to a variety of rigid substrates. Wave or dip soldering components directly to the circuit greatly reduces assembly costs of components. In addition, interlayer connections can be made between any layer without surface exposure. Conductor thickness may be from less than 1 oz. to more than 6 oz. copper. Sanders Associates, Inc., 95 Canal St., Nashua, N. H.

Circle 254 on Inquiry Card

NEW PRODUCTS

COMPACTRON TUBE

Contains 2 pentodes. Used as a 2-stage video i-f TV amplifier.



The 9BJ11 Compactron offers sensitivity equal to some 3-stage amplifiers. It can lower costs, improve performance levels, and conserve space in the manufacture of monochrome TV receivers. Construction features of the input section eliminate the need for a gain-robbing unbypassed cathode resistor. It provides high transductance and low capacitance in each section. High-input impedance unloads the mixer stage for improved tuner gain. General Electric Co., 3800 N. Milwaukee Ave., Chicago, Ill.

Circle 255 on Inquiry Card

ZENER REGULATORS

Offers 1% stability at 20kv. Each unit offers 20 built-in regulated taps.

Connected in parallel with a high-voltage supply, these regulators automatically regulate both line and load voltage. Where nominal current across the diodes is held to 0.5 to 1ma, regulation is 1% or better. Regulation is 3% with current of 1 to 3ma. Four basic units are available for max. voltages of 1 through 4kv. Industrial Instruments Inc., 89 Commerce Rd., Cedar Grove, N. J.

Circle 256 on Inquiry Card

MAGNETIC AMPLIFIERS

Input is 115v 400 CPS; output is ±7.5vdc, 1000Ω load; 2 isolated control inputs.

The MAS series are solid-state push-pull magnetic amplifiers. These magnetic amplifiers afford a power gain of approx. 30,000. The power input and output are also completely and individually isolated. The MAS magamps are manufactured to Mil-T-27B standards. Units are housed in a hermetically sealed steel case with plug-in octal compressed glass terminals. United Transformer Corp., 150 Varick St., New York, N. Y.

Circle 257 on Inquiry Card

RFI MEASURER

Uses solid-state circuits. Operates in the freq. range of 14KC to 1GC.

Interference Analyzer Model EMC-25 meets military and commercial requirements for automated RFI data acquisition. It can be scanned over the entire freq. range and has remotely controllable band selection. A choice of 2 bandwidths is standard. Detector functions provided are carrier, peak, 60db scan, slideback and FM deviation. In 60db scan, a full 60db range can be read on the meter without changing input attenuator settings. Outputs for phones, external meter, X-Y recorder, i-f and video are used. The unit operates on ac or battery. Electro-Metrics Corp. subs. Fairchild Camera & Instrument Corp., 88 Church St., Amsterdam, N. Y.

Circle 258 on Inquiry Card

STANDING WAVE DETECTOR

For VSWR and impedance measurements in the V-band through W-band freq. range.

The TE_{01} Mode Standing Wave Detectors can be used in either test bench or production line uses. In production testing, it determines VSWR, impedance, phase and loss characteristics of all types of TE_{01} mode waveguide components. TRG Control Data Corp., Route 110, Melville, N. Y.

Circle 259 on Inquiry Card

TRANSISTOR TESTER

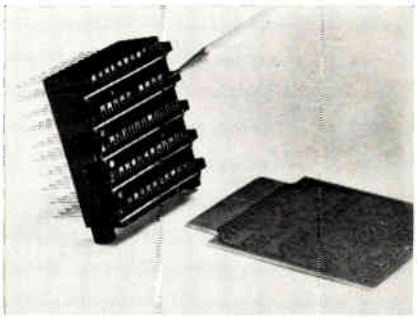
Designed for accurate in-circuit measurement of leakage current.

This lightweight unit is portable and accurately measures collector-to-base leakage currents as low as 1μa with a collector load resistance down to 100Ω. A 0-25μa meter with a taut-band movement reads leakage currents and indicates transistor shorts and opens with complete safety for all components. Max. ranges on the 3-range scale are 25, 250 and 2500μa. It may be operated by non-skilled personnel. Transition Inc., 10 W. 35th St., Chicago, Ill.

Circle 260 on Inquiry Card

PC BOARD RECEPTACLES

For use where numerous PC board interconnections are needed.



The connectors of the PMTip Series 231 are stacked side-by-side in frames and interwired. Close dimensional tolerances insure a minimum of mounting and terminating problems. Advantages include: low cost per contact because precious metal is used at the mating surface; space savings due to high density of contacts; possible use of PC board card guides with the connector; PC board lands are not damaged even with max. insertions and withdrawals; and strength and dimensional stability due to the high-impact, molded phenolic body of the unit. Available with 180 contacts on 0.125 in. centers. Units are rated at 500v. RMS at 7.5a. Breakdown voltage is 1800 v. RMS. Amphenol Connector Div., 1830 S. 54th Ave., Chicago, Ill.

Circle 261 on Inquiry Card

TRANSFER SWITCHES

Can be used in systems developing 100ka fault currents, without switch damage.

This improved line of automatic mechanically-held transfer switches feature current-limiting low-peak fuses. This feature enables the switch to withstand momentary short circuit or fault currents that can be developed in the power system. Zenith Electric Co., 152 W. Walton St., Chicago, Ill.

Circle 262 on Inquiry Card

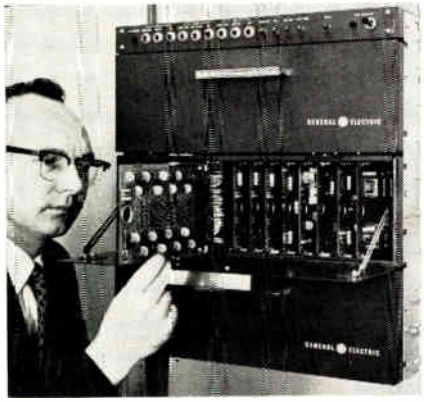
CERAMIC FLAT PACKS

Packs with as many as 28 leads are available off the shelf.

The AlSiMag are large all-ceramic flat packages for thin film networks. They are being produced in sizes from ½ in. sq. to over 1 in. sq. with as many as 16 leads on each side. A ¾ x ⅞ in. package with 28 leads is available with no tooling charge. American Lava Corp., Manufacturers Rd., Chattanooga, Tenn.

Circle 263 on Inquiry Card

MOBILE TELEPHONE



U. S. General Services Administration now using this solid state command terminal in Federal Telecommunications System in Boston area. Designed by General Electric, it provides switching, signalling, and audio amplification for two-way communication manual or direct-dial radiotelephones and landlines.

JOINT PROGRAM

Sprague Electric Co., North Adams, Mass., and Manson Laboratories Division of the Hallicrafters Co., Wilton, Conn., announced a joint program to manufacture and market pulse assemblies for radar modulators. Technical abilities of both firms will be called upon.

OCEANOGRAPHY SENSOR

An FM output pressure transducer that does not need the usual heater requirements for deep ocean submersion has been developed by Fairchild Controls. The device, available in a number of models, uses the TELE-WIRE®—a vibrating wire in a magnetic field, which, under tension or relaxation, produces an FM output as a function of pressure change. Fairchild engineers report that such an output is ideally suited for oceanography where pressure variations thousands of feet deep are urgently sought.

INFRARED DETECTOR

A highly accurate measurement of hot metal strips and plates is now possible at reasonable cost with a new infrared detector system from the Westinghouse Relay-Instrument Division. A gauge picks up IR radiation through lenses and a scanning disc. Motor-driven discs provide a coordinated scan of the metal with impulses from reluctance pickup heads on the discs. The system can measure metal of temperatures ranging from 1,500 to 2,200°F, and a maximum dimension of 730 cm.

STEPPING RELAYS *(from page 48)*

switching in antenna changeover systems, pulse forming networks, nuclear apparatus and medical equipment.

Many high voltage relays are custom built since each new application, differing from the previous one, presents new problems, making it impractical if not impossible to establish a "rule of thumb" for high voltage relay design. Factors such as temperature variations, humidity, and other atmospheric conditions including the amount and type of impurities in the air can dictate major changes in the design of high voltage relays. D-C and high frequency relays require separate standards of their own, particularly high frequency relays where increased tendencies toward corona discharge, creepage and dielectric heating of the insulation make it advisable to further increase spacings. Design of high voltage relays is a field where know-how really counts and where highly specialized relay engineering is required.

Vacuum relays are widely used in switching extremely high voltages and high peak currents. They are much smaller than conventional relays with similar ratings. New miniature vacuum types weigh as little as an ounce and can switch 5 KV in 500 microseconds. A few reed type relays are produced for high voltage applications. These were listed in the March EI issue.

CORRECTIONS

The editors of ELECTRONIC INDUSTRIES wish to call attention to the following inaccuracies in "Part 1: Reed Relays and Sensitive Relays" which appeared in the March, 1965 issue:

The address of *Potter & Brumfield* is 1200 E. Broadway, Princeton, Indiana, not Franklin, Kentucky, as listed under "Reed Relays." The address is correctly given under "Sensitive Relays."

Hathaway Instruments as it appears in "Reed Relays" is improperly identified. It is no longer a subsidiary of Lional Corp.

The *RBM Controls Division of Essex Wire Corp.*, 131 Godfrey Street, Logansport, Indiana, was incorrectly identified in the "Reed Relay" listings as RBM Development Corp.

ELECTRONIC INDUSTRIES

Advertisers — May 1965

This index is published as a convenience.
No liability is assumed for errors or omissions.

EIA GROUP INVESTIGATES BOGUS SEMICONDUCTORS

The Semiconductor Division of the Electronic Industries Association disclosed that a three-man task force from its ranks will study reports of counterfeiting in semiconductor devices.

The group, headed by Robert J. Maijer, international marketing manager, Bendix Semiconductor, will determine the extent of the alleged counterfeiting and will recommend action to be taken by EIA and manufacturers if the need is indicated. The group will report during the annual EIA convention in Chicago this July.

The consensus of the Semiconductor Division's executive committee is that the problem appears serious, though it does not appear to be widespread as yet. NASA officials reported some experience with counterfeit devices.

ARMY'S FUTURE R&D

A three-day symposium, classified as SECRET, to acquaint industry with the Army's plans for future research and development in communications and electronics will be held at Fort Monmouth, N. J., June 15, 16, and 17.

Highlighting the Symposium, presented by the Army Electronic Command (ECOM) and the Fort Monmouth chapter of Armed Forces Communications and Electronics Association (AFCEA), will be a discussion of the new Qualitative Development Requirements Information (QDRI) Program.

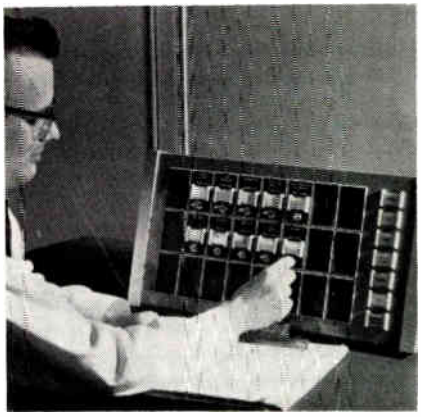
LOWER PLATING COST

A new automatic machine permits plating of functional precious metals at one-third usual cost, according to Platronics, Inc., Linden, N. J. The company says its new technique can be "programmed" to apply platings only where needed for improved functional characteristics. Such "spot" coatings can cut production costs of many finished components in half, say Platronics engineers.

TELEMETRY SYSTEM

A dual diversity receive-record telemetry system designed and built by Electronic Specialty Co. has been delivered to the Pacific Missile Range, Pt. Mugu, Calif. After completion of evaluation and acceptance tests the system will be installed at a downrange location.

REMOTE-CONTROL UNIT



Standardized remote-control system called Conitel 10 for general industrial use can control and supervise up to 24 devices, which operate field equipment such as circuit breakers, valves and pumps. Designed by General Telephone & Electronics, the system can operate over any communications media.

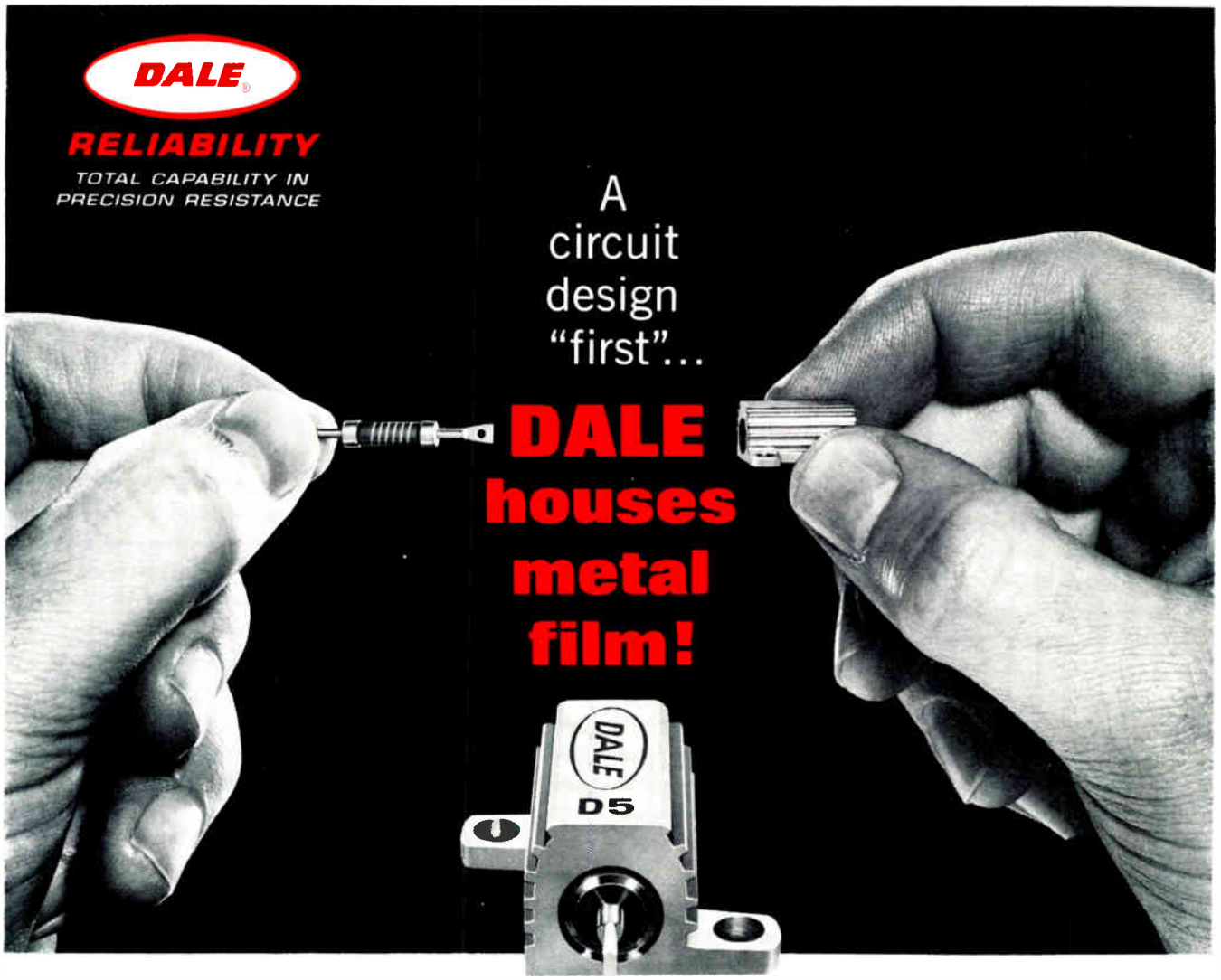
MARKETING AGREEMENT

Two firms, Radiation, Inc., Melbourne, Fla., and Data Systems, Inc., of Detroit, subsidiary of Union Carbide Corp., disclosed signing of an agreement under which both firms will pursue marketing opportunities in the automation of chemical processing plants.

DALE®

RELIABILITY

TOTAL CAPABILITY IN PRECISION RESISTANCE



Now-new design flexibility and more power from DALE D5-the industry's first housed film resistor

Dale's new D5 is the industry's first housed power film resistor. It combines a heat sink housing already proven by Dale Wirewounds, with a precision power metal film element. The result:

1. As a FILM RESISTOR, Dale's D5 offers power/size ratio unmatched by conventional parts (see chart).
2. As a HOUSED RESISTOR, Dale's D5 offers higher maximum resistance values and low reactance at high frequencies.

We'll send you complete details on this amazing design flexibility. Write, wire or phone us today.

FILM RESISTOR POWER/SIZE COMPARISON

CHARACTERISTIC	D5 (4 WATTS)	2-WATT METAL FILM	5-WATT CARBON FILM	4-WATT TIN OXIDE
SIZE	.33 .60 .32	.3/8 2 1 16	.7 16 4	.5 16 2 1 16
VOLUME	0.064 in.^{3}	0.242 in.^{3}	0.600 in.^{3}	0.145 in.^{3}
POWER DENSITY (25 C)	62.0 w/in.^{3}	8.3 w/in.^{3}	8.3 w/in.^{3}	27.6 w/in.^{3}
POWER DENSITY (125 C)	19.6 w/in.^{3}	8.3 w/in.^{3}	2.1 w/in.^{3}	13.8 w/in.^{3}

D5 SPECIFICATIONS

- **Resistance Range:** 50 Ω to 1 megohm
- **Tolerance:** ±0.1%, 0.25%, 0.5%, 1% and 2%
- **Power Rating** 4 watts mounted on 4"x6"x.040" aluminum chassis
- **Temperature Coefficient:** ±25 and ±50 ppm/ C (−55 C to +175 C) higher T.C.'s on request
- **Maximum Working Voltage;** 500
- **Dielectric Strength:** 1000 VAC
- **Construction:** Aluminum screw-mount radiator housing with resistance element molded inside for complete environmental protection. Meets all applicable requirements of MIL-R-18546C and MIL-R-10509E.

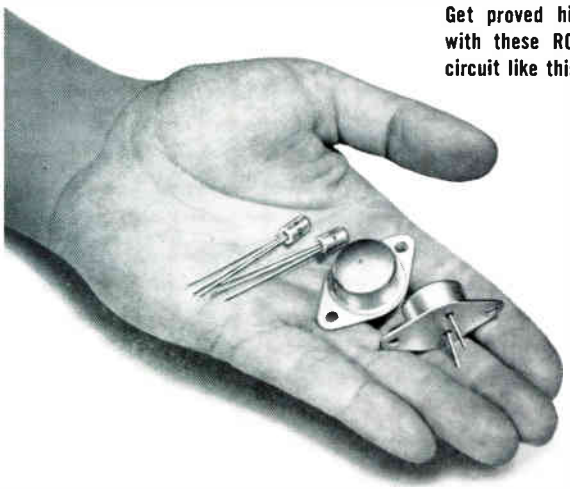
DALE **DALE ELECTRONICS, INC.** 1304 28th Avenue, Columbus, Nebraska

Also Sold by Dale Electronics Canada Ltd., Toronto, Ontario, Canada

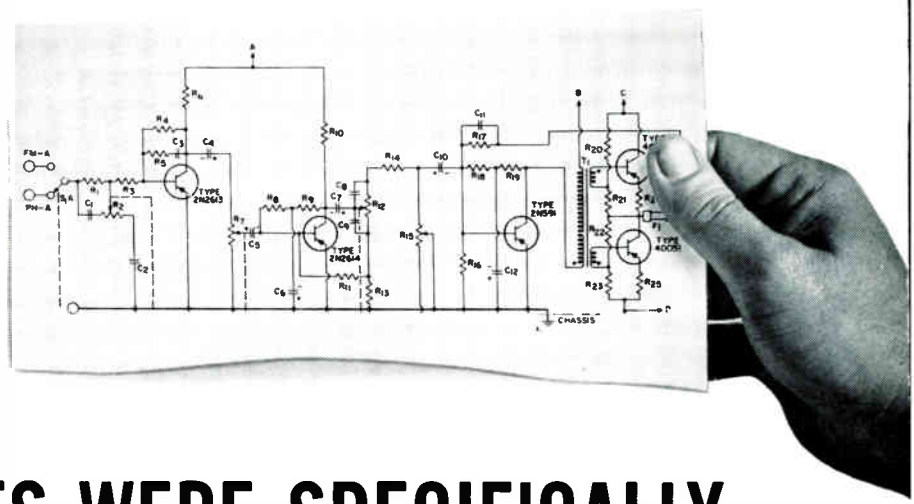
Circle 98 on Inquiry Card

VSMF

THIS RCA TRANSISTOR COMPLEMENT OFFERS THE BEST HI-FI TRANSISTOR VALUE ON THE MARKET TODAY...



Get proved high-performance at low cost with these RCA transistors and a simple circuit like this:



WHY? THE DEVICES WERE SPECIFICALLY DESIGNED FOR THIS APPLICATION. MILLIONS OF THESE TRANSISTORS ARE NOW IN USE!

Check the performance of this typical, low-cost amplifier circuit: high gain with low distortion over a wide frequency range (response flat from 30 cps to 12,000 cps ± 3 db). It delivers 25 watts (RMS continuous) output power (37.5 watts music power) with a 4-ohm load. It can be driven by a tuner output or by standard ceramic phonograph pick-ups.

Get all this excellent performance with these four RCA transistor types:

INPUT STAGE: RCA-2N2613 high-gain, low-noise (4 db max) P-N-P alloy-junction small-signal audio amplifier transistor.

PREDRIVER STAGE: RCA-2N2614 • P-N-P high-gain, high-voltage alloy-junction small-signal audio amplifier transistor.

DRIVER STAGE: RCA-2N591 • P-N-P high-gain, large-signal driver transistor.

OUTPUT STAGE (Class B): Two RCA-40051 • P-N-P alloy-junction power transistors featuring high-gain and excellent linearity.

Millions of these units are now in use, proving the built-in dependability of these mass-produced RCA transistors.

For full technical information request your copy of Advanced Application Note ST-2650 from your nearest RCA Field Office, or write to RCA Commercial Engineering, Section E J 5, Harrison, N.J.

AVAILABLE THROUGH YOUR RCA DISTRIBUTOR

RCA ELECTRONIC COMPONENTS AND DEVICES

The Most Trusted Name in Electronics

Circle 118 on Inquiry Card