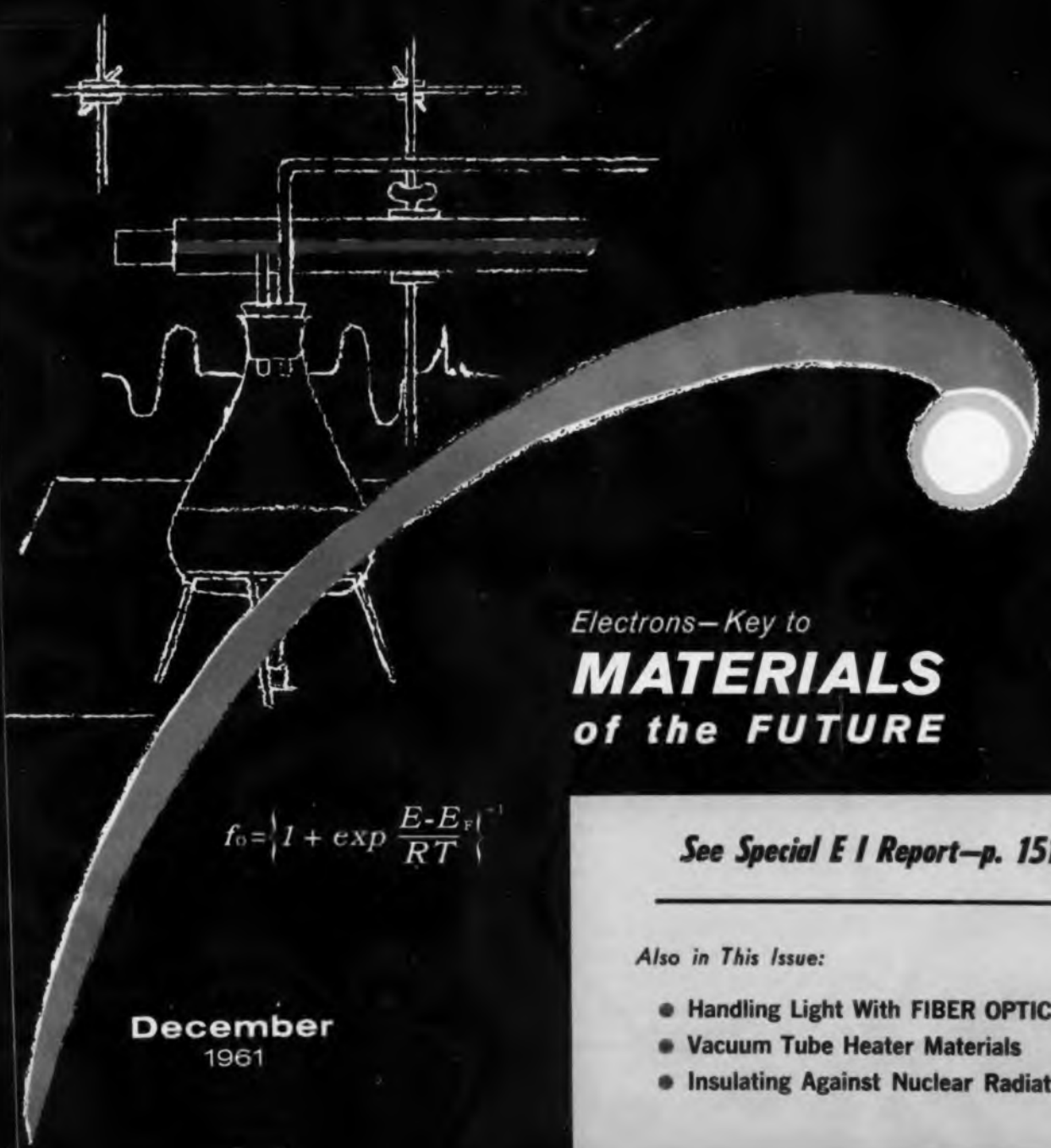
# ELECTRONIC INDUSTRIES

A CHILTON PUBLICATION



*Electrons—Key to*

## MATERIALS of the FUTURE

$$f_0 = \left\{1 + \exp \frac{E-E_F}{RT}\right\}^{-1}$$

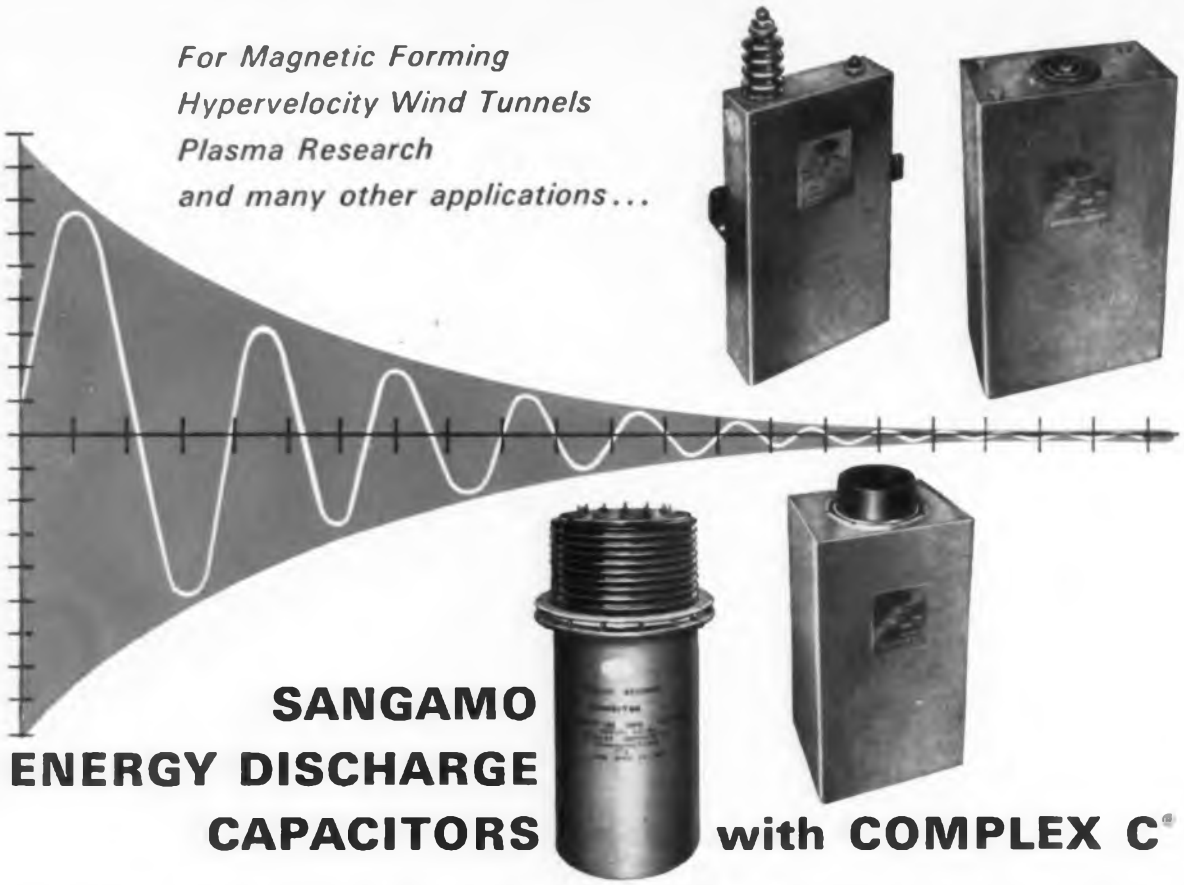
**See Special E I Report—p. 151**

*Also in This Issue:*

- **Handling Light With FIBER OPTICS!**
- **Vacuum Tube Heater Materials**
- **Insulating Against Nuclear Radiation**

**December**
1961

*For Magnetic Forming*
*Hypervelocity Wind Tunnels*
*Plasma Research*
*and many other applications...*



# SANGAMO ENERGY DISCHARGE CAPACITORS with COMPLEX C®

## *meet the most demanding electrical and mechanical design criteria*

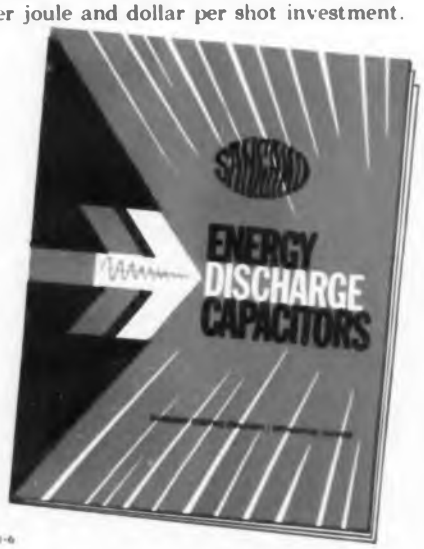
Sangamo *knows* energy discharge capacitors and their application—a Sangamo research team has spent years in establishing detailed design criteria to meet the requirements of every conceivable capacitor bank. The energy discharge units developed by Sangamo meet the exact requirements specified, in order to give you the most for your investment in a large energy discharge capacitor bank.

The most significant advance in this field is the development of Complex C (Sangamo's exclusive dielectric impregnant and fill). The use of Complex C, with all other characteristics and circuit conditions being equal, results in a life expectancy 10 to 100 times that previously possible. The exceptional life expectancy of Sangamo Complex C capacitors will give you the most for both your dollar per joule and dollar per shot investment.

**SEND FOR SANGAMO'S BULLETIN TSC-208 FOR FULL INFORMATION ON THESE CAPACITORS**

The complete story of the design criteria behind Sangamo high voltage, low inductance, energy discharge capacitors is told in detail in this new bulletin. It contains valuable information on possible circuit applications, methods of determining self-inductance of a capacitor, and standard capacitor listings that represent typical values for your energy discharge applications. Your copy will be sent on request. Address:

**SANGAMO ELECTRIC COMPANY**
SPRINGFIELD, ILLINOIS




SANGAMO *ELECTRONIC COMPONENTS*

EC61-6

Circle 1 on Inquiry Card

# ELECTRONIC INDUSTRIES

ROBERT E. McKENNA, Publisher • BERNARD F. OSBAHR, Editor

## Welcome Developments on Capitol Hill

IN the past four weeks we have seen three U. S. Senators and one U. S. Congressman get up in Washington to make recommendations that will strongly affect certain areas of electronics. One of the recommendations is so detailed that it gets down to pointing at a certain product.

Sen. Hubert H. Humphrey (D., Minn.) urged a "vast expansion" in U. S. Government support of medical electronic research and development. The U. S., he said, is today supporting 273 "extramural" projects in medical electronic research aggregating $8.4 million. In addition, Federal agencies are carrying on 93 projects in their own laboratories. A "systematic, coordinated effort" is needed, said Humphrey, so that medical science can capitalize for civilian purposes on defense-supported discoveries and technology.

At the same time Congressman Victor L. Anfuso (D., N. Y.), a ranking member of the House Committee on Science and Astronautics, was informing top government officials that the field of solar energy conversion "is now on the verge of a technological breakthrough" that will result in the production of direct solar to electrical generating devices at a reasonable cost. He gave his opinion that a 2-year research program would result in lowering the cost of producing solar-powered devices from about $200 per watt at present to a "more realistic $50 per watt." He called on the Government leaders to "thoroughly investigate the possible advantages of solar research" and to support such research activities in Government and in private industry.

At another session Sen. Russell B. Long (D., La.), after concluding eight days of hearings on the subject of space communications satellites gave as his private opinion that "there are any number of major American corporations which would present proposals on how to set up a satellite communications system if permitted to do so, but these corporations have done nothing about it because of a feeling of futility."

Sen. Prescott Bush (R., Conn.) was warning that the acute shortage of technicians "constitutes a national emergency." The Connecticut senator is the author of an amendment to the National Defense Education Act designed to stimulate the training of highly skilled technicians.

This concentrated attention to problems of our industry is very heartening. It has been our opinion for many years —and we have stated it strongly in this column—that what we need in Washington is more legislators with an understanding of the technical industries, and their unusual characteristics.

We would like to add parenthetically that we are certainly not recommending more government intervention in private business. It is simply a fact that the U. S. government is the single largest customer of the electronic industry, and we feel that more knowledgeable people on the procurement end would mean better utilization of taxpayers' dollars. (We pointed out in our article, "What Price Reliability?," in the Sept. 1961 issue, the damage that unrealistic procurement practices were doing to both government and industry in the development of military electronic equipment.)

A word of caution is called for here: It would be unfortunate if Senators and Congressmen studying certain areas of the electronic industry were to restrict their inquiries to one or two companies. Like most other industries the electronic industry is a composite of thousands of firms, each with its own unique abilities and products. It would be unseemly if legislators on Capitol Hill were to put their personal stamp-of-approval on various electronic products without adequately surveying the field.

— C.M.M.

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# ELECTRONIC INDUSTRIES

Vol. 20, No. 12 December, 1961

FRONT COVER: Our feature EI Staff Report this month deals with the new Materials that the electronic industry is dealing with. The key to these new materials, as readers will learn in the article, beginning on page 151, is the free electron. How its behavior affects the composition of materials, most particularly insulators, semiconductors and conductors, is the meat of this very thorough technical treatment.

## MONTHLY NEWS ROUND-UP



## NEW PRODUCTS & TECH DATA

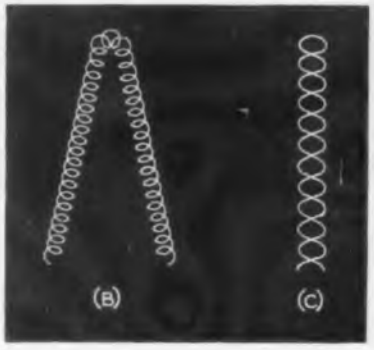


## DEPARTMENTS

# Highlights of this issue



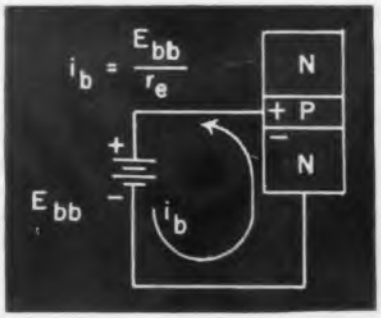
New Materials




Tube Heaters


Fiber Optics

Junction Transistor



# RADARSCOPE

**TEACHING MACHINES**

Class of U. S. postal workers is here being re-trained to handle the skills required by automation. Instruction is supplied by Digiflex machines, products of U. S. Industries Inc., Silver Spring, Md. The students stations are in foreground, instructor's at right rear.

**CRYSTAL-GROWING TECHNIQUE** developed by E. A. D. White of General Electric Co., Ltd., England, produces good-quality crystals of pure corundum or ruby by dissolving the materials in lead fluoride. Process is carried out in platinum crucible heated in laboratory furnace. Incorporation of high concentrations of paramagnetic ions, highly desirable for maser crystals, is easily achieved with new method.

**IRE AND AIEE** are moving to consolidate. A joint committee has been formed to determine the feasibility and form of the consolidation. The proposed new organization would be international in scope and involve 150,000 engineers, scientists, educators and industrialists.

**IMPROVED METHOD** of manufacturing high purity ceramics for electronic applications appears likely through a current Air Force research project. The production process, a direct metathetical precitation of tetragonal barium titanate powder was used in the research to produce 99.95% $BaTiO_3$ in pre-pilot plant lots. A pilot plant was designed which it is believed will now be capable of producing 25 pound lots.

**DESIGN CRITERIA** for a basic UHF telemetry transmission link to meet the requirements of missile programs for the next 10 years have been drafted by the Navy. The required characteristics of telemetry transmitters, receivers and antennae to be used in future Navy UHF telemetry transmission systems are specified in a Naval Ordnance Laboratory report released through the Office of Technical Services, BDSA, U. S. Department of Commerce, Wash. 25, D. C., as Report #PB 171960.

**NEW CERAMIC WAFER** uses printed circuitry to form capacitors and resistors as well as conducting lines, according to a research report from the Air Research and Development Command. Basic element is RC circuit plate—a ceramic wafer containing conductive, resistive, and dielectric layers. Plate is converted into RC circuit by a series of stenciling and selective etching steps; stenciling is done by xerography. For more information Order PB 171 380 from OTS, U. S. Dept. of Commerce.

**NEW CLOSED-CIRCUIT TV** development, bi-lateral cable TV, permits for the first time, simultaneous video and audio transmission and reception in both directions on a single co-axial code. Developer, Entron, Inc., points out that industry can now use television as an effective means of instantaneous two-way communication at considerably reduced costs.

**DEFENSIVE ELECTRONIC COUNTERMEASURES**

The non-magnetic covering on the belly radome of a supersonic B-58 "Hustler" bomber is inspected by General Dynamics' J. Harwell, (l.) and E. E. Wayman, field engineer for Sylvania Electric Products Inc. Radome covers a Sylvania-built defensive electronic counter-measures system (DECM) which absorbs radar pulses, kills return.

**PUERTO RICO'S COMMUNICATIONS** industry has been ordered to pay a minimum wage rate of $1.00 an hour by the U. S. Labor Department. The rate became effective November 3, 1961.

**EIA'S** Working Group on Wire-Wound Resistors has invited industry to participate in a stepped-up program of standardizing wire-wound resistors. The engineering working group, designated P-1.4, will give particular attention to existing EIA specifications and specific military specifications. Participation is not restricted to EIA member-companies. Interested companies may contact J. Howard Schumacher, EIA Engineering Department, 11 West 42nd Street, Room 2260, New York 36, N. Y.

**EXPORTS OF BUSINESS MACHINES** from the U. S. totaled $154,750,825 in the first six months of this year, a 64.5% increase over the same period of 1960, and imports were $47,206,746, a 33.2% increase over the first half of last year. Canada was the best market for U. S. business machines, followed closely by Japan, but exports to European countries showed the greatest percentage increase—98%. Exports to Asia and South America also showed important gains. In both of these areas U. S. producers have been meeting increasing competition from European producers.

**FIRST SMALL BUSINESS POOL** formed specifically to perform government R & D contracts was announced by the Small Business Administration. Composed of four small firms in New York City area, the pool will seek government R & D contracts in physics, radiation, optics, inertial guidance and electronics. The pool, the N. Y. R. A. D. Team, Inc., has offices at 150 Broadway, New York City. Included in the new pool are: Aerolite Electronics Corp., Union City, New Jersey; Manhattan Physical Research Group, Inc., New York City; New York Testing Laboratories, Inc., New York City, and Radiation Research Corp., Westbury, Long Island, New York.

**NATIONAL SCIENCE FOUNDATION** has initiated a new program to supply scientific equipment for undergraduate instruction. Colleges and universities granting science bachelors degrees may request funds to assist them in purchasing scientific equipment to be used in the laboratory or in lecture-demonstration sessions. Examples of equipment eligible for purchase under the program include microscopes, centrifuges, microtromes, test equipment, and similar scientific apparatus. Proposals may not exceed $25 thousand in order that the widest possible group of departments may benefit. All grants in this program are required to be on a matching basis with at least 50% of the direct costs to be incurred derived from non-Federal sources.

**SCIENTIFIC AND TECHNICAL INFORMATION** in libraries and information centers would be made available to researchers faster under an Air Force proposal to establish a "materials information processing capability." Details are spelled out in a report now available through the Office of Technical Services, Business and Defense Services Administration, U. S. Department of Commerce, Washington 25, D. C. The new information processing capability would use computers to sift descriptive information and empirical data in order to provide scientists with primary information applicable to immediate problems. Target time for information retrieval would be on the order of minutes for simple questions, ranging upward to a few hours for more complex searches. Background, "fill-in" information chores would be left to existing libraries. Key to the system would be a multidimensional matrix displaying all current materials information sources, ranged against material types. An organization matrix outlined in this report was developed from a highly cross-referenced file of 500 current data and information processing projects.

## SPACE SATELLITE SIMULATOR

**At Minneapolis-Honeywell's new $5 million aerospace facility in Minneapolis satellite simulator provides realistic test conditions for guidance and control systems. The 2-ton structure is suspended on an air bearing, so delicately that fly's weight moves it.**

# They said "PROVE IT"... AND WE DID!

**The moisture-resistance curves show how Type 160P Difilm® Black Beauty® Capacitors outperform all other commercial tubulars**

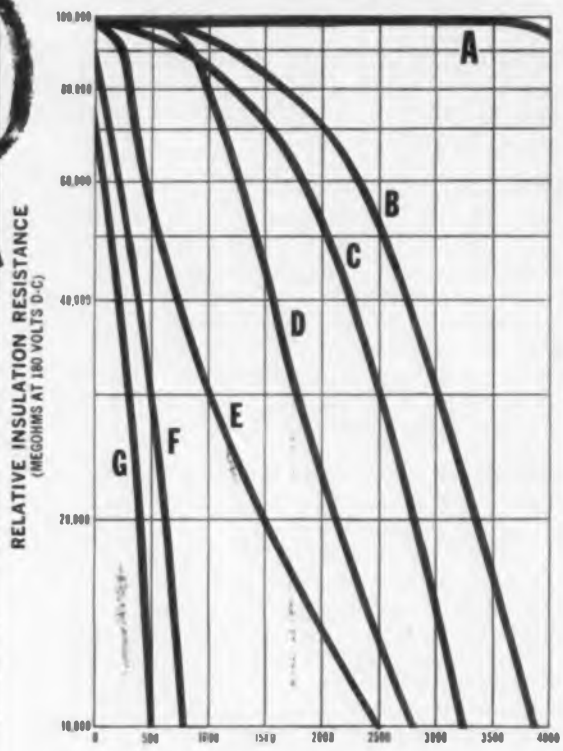

To test tubular capacitors, we figuratively brought jungle conditions into the laboratory. The curves tell what happened.

Difilm Black Beauty Molded Capacitors withstood almost 4000 hours (95 to 100% R. H. at 40 C) with *no change in humidity resistance!*

No other tubulars came close to this performance. Difilm Capacitors proved themselves the *true* answer to moisture problems in entertainment and commercial electronics.

*For complete technical data on Difilm Black Beauty Capacitors, write for Engineering Bulletin 2025 to Technical Literature Section, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.*

**MOISTURE RESISTANCE COMPARISON CHART FOR TUBULAR CAPACITORS**




**A. DIFILM® DUAL DIELECTRIC (PAPER and POLYESTER FILM), solid impregnant, molded case**

- B. PAPER DIELECTRIC, solid impregnant, molded case
- C. DIFILM DUAL DIELECTRIC (PAPER and POLYESTER FILM), solid impregnant, dipped coating
- D. POLYESTER FILM DIELECTRIC, molded case
- E. PAPER DIELECTRIC, wax or oil impregnant, molded case
- F. PAPER DIELECTRIC, solid impregnant, waxed cardboard jacket
- G. PAPER DIELECTRIC, wax or oil impregnant, waxed cardboard jacket

**You can get off-the-shelf delivery at factory prices of Replacement Type TM Capacitors (same construction as O. E. M. Type 160P) in pilot quantities up to 249 pieces from your local Sprague Industrial Distributor.**

**SPRAGUE COMPONENTS**

| | | |
|---|---|---|
| CAPACITORS | INTERFERENCE FILTERS | HIGH TEMPERATURE MAGNET WIRE |
| RESISTORS | PULSE TRANSFORMERS | CERAMIC-BASE PRINTED NETWORKS |
| MAGNETIC COMPONENTS | PIEZOELECTRIC CERAMICS | PACKAGED COMPONENT ASSEMBLIES |
| TRANSISTORS | PULSE-FORMING NETWORKS | FUNCTIONAL DIGITAL CIRCUITS |

**SPRAGUE®**
*THE MARK OF RELIABILITY*

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# As We Go To Press...

**INERTIAL PLATFORM**

This all-attitude inertial platform, weighing less than 20 lbs., is the heart of a compact shipboard navigational system being built by United Aircraft Corp's Norden division in Norwalk, Conn. System will determine accurate position, velocity, and angular reference data for the navigation and weapons fire control of ships.

## New Broadcasting Branch Established by FCC

The FCC has established an Educational Broadcasting Branch in its Broadcast Bureau. The new branch has been made part of a Research and Education Division which absorbs the former Economics Division. It is responsible for the performance of all functions of the Broadcast Bureau relating to compilation of information, the conduct of studies and the making of recommendations relating to educational broadcast services, and serving as a clearing-house of information for and liaison with private and government groups interested in or involved with educational broadcasting.

The re-designed division compiles data and prepares reports to the Commission on the conditions and status of the broadcast industry; studies the social and economic factors affecting communications, and advises the bureau and the Commission with respect to the development and promotion of the educational broadcasting and the commercial broadcasting services. Hyman H. Goldin, who was chief of the former Broadcast Economics Division, has been named head of the augmented division.

## Sentinel Service System Demonstrated

Philco Corp. recently demonstrated to civil defense authorities in Washington, D. C., its new Sentinel Service, an automatic radio warning system capable of alerting 95% of the U. S. population within seconds after an attack alarm is sounded.

The Sentinel system stands guard 24 hours a day, ready instantly to turn on any radio equipped with the newly developed circuitry. The special circuit draws so little from the batteries that a set equipped with standard D batteries would be expected to function 30 to 45 days without recharging.

The Sentinel Service would also allow all families to take to fallout shelters a radio which could be left on stand-by to receive Civil Defense warnings and instructions.

## Laser Development Contract Issued

Air Force's Rome Development Center has contracted Electro-Optical Systems, Inc., to develop advanced laser components for use in optical surveillance systems. Program goals include investigation of new techniques and materials used in laser amplifiers, oscillators, and coherent detectors. Emphasis will be placed on CW lasers and high power pulsed lasers where a high degree of spectral purity and high repetition rates are required.

**"MOON ROLLER"**

Developed by RCA, this rolling balloon device being demonstrated by Joan Brush, incorporates directional motivation with sun-powered TV "eyes" and multiple electronic sensing instruments. Planned for use on the moon, it would take samples of the moon's surface and transmit back to earth what it finds and sees.

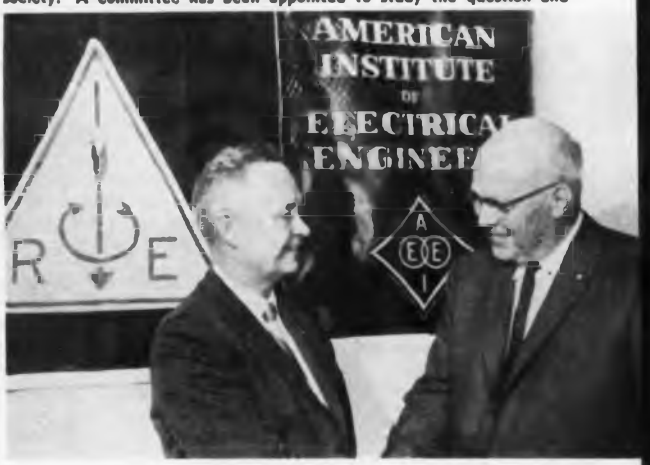
## Direction Finder Contract Increased

As part of its program to assure safety for the airlanes, the FAA has awarded Servo Corp. of America, Hicksville, N. Y., an additional $1 million for VHF/UHF advanced Doppler direction finders under contract awarded to Servo in September. This brings the total contract figure to over $2,700,000 and increases the number of units to 190.

These new direction finders, providing bearings accurate to 1 degree to the pilots, will be installed in stations throughout the United States, Alaska, and Hawaii operated by the FAA to help insure the safety of lost aircraft.

**AIEE & IRE HEADS CONFER**

P. E. Haggerty, President-Elect of the 90,000 member IRE, (1) and W. H. Chase, President of the 70,000 member AIEE, confer on first steps to consolidate their organizations into one international engineering society. A committee has been appointed to study the question and make a report by Feb. 15, 1962. The plan will be submitted to the membership of both organizations. If approved, target date for "consummation" is Jan. 1, 1963. Mr. Hagerty is President of Texas Instruments, Inc., Dallas, and Mr. Chase is Vice President of the Ohio Bell Telephone Co.




More News On Page 8

# Electronic SHORTS

**A new method for air-launching the Blue Scout rocket into a deep space probe or into orbit from the X-15 has been announced by Ford Motor Co., prime contractor for the USAF Blue Scout, and North American Aviation. designer and builder of the X-15. In the proposed system, the Boeing B-52 bomber would act as the first stage booster, the X-15 as the second stage, and the Blue Scout as the third and fourth stages.**

National Science Foundation has contracted Texas Instruments Inc. to provide an oceanographic measurements team for duty aboard a research vessel participating in the U. S. Antarctic Research Program. The team will maintain a variety of scientific equipment aboard the USNS ELTANIN, which is scheduled to operate in Antarctic waters under a lease agreement between the Foundation and the Military Sea Transportation Service (MSTS).

**A Southern California firm of scientists will soon begin the site survey, installation and operation of the world's largest known seismic observatory designed to detect and measure underground nuclear explosions anywhere in the world. United ElectroDynamics, Inc., of Pasadena will construct the research center in Tonto National Forest near Payson, Ariz. It will be known as the Tonto Forest Seismological Observatory.**

Scientists from Lockheed Missiles & Space Co. have warned that human life on earth could be wiped out by strange new microbes from other planets—unless an effective decontamination method is developed before the first round-trip space vehicles are launched. An intensive five-year program covering study of biological decontamination techniques and building of ground and in-flight sterilization units is proposed by a team from Lockheed.

**A contract for celestial navigation devices amounting to approximately $9 million has been awarded Kollsman Instrument Corp., Melrose Park, Ill., by the Autonetics Div. of North American Aviation. The Autonetics order calls for Kollsman KS-140 astro-tracker systems and spares to be installed on North American's "Hound Dog" missiles.**

According to a survey by the Western Electronic Manufacturers Association (WEMA), more than half of the electronic manufacturing firms in the West are privately owned corporations and are less than 10 years old. Less than 25% of today's western companies were in existance at the end of World War II, according to the study.

**The Federal Aviation Agency has ordered 11 additional radar bright display systems for better presentation of radar information to air traffic controllers. Raytheon Co. of Lexington, Mass. will furnish the systems under a $1,583,000 increase in a previous contract bringing to 51 the number of bright display systems the FAA has on order from the Massachusetts firm.**

Republic Aviation Corp. has announced receipt of a study contract from the Bureau of Ships for the development of improved emergency controls for submarines. Purpose of the study is to improve the handling qualities of submarines in the event of malfunctioning of normal diving and steering controls. Initial phase of the study will determine requirements for an emergency system that can be adapted to any new submarine class.

**Receipt of a contract to participate in a billion dollar expansion program at O'Hare International Airport, Chicago has been received by Electronic Control Products, Div. of Electronic Fabrication Labs, Dunellen, N. J. The contract calls for the installation of the ECP Mark IV supervisory/Control System to control the airport's $5 million refueling complex.**

NATO has called for $1,655,000 worth of electronic equipment for immediate delivery from Electronic Assistance Corp., Red Bank, N. J. This makes more than $2,000,000 worth of electronic equipment ordered for NATO defenses under an "open call" contract with NATO's procurement wing, the Maintenance Service Supply Agency. An "open call" contract is an agreement under which NATO can put in calls for equipment continuously without negotiating a new contract for each call.

## *Boeing & Arnoux Sign Agreement*

The Boeing Co. and Arnoux Corp. of Los Angeles have entered an agreement for the manufacture and sale of a line of Boeing-developed electronic medical and telemetry devices. Under terms of the agreement Arnoux will have an exclusive license to make and sell the miniaturized instruments in the U. S. and Canada.

Principal item is a newly developed miniaturized wireless telemetry system to be used in conjunction with the medical instruments. Also included are an electrocardiograph to monitor heart beat, a respiration meter to measure breathing, a phonocardiograph for heart sounds, an electroencephalograph for brain activity, a thermometer and an oxygen consumption meter.

## *New Facility Opened*

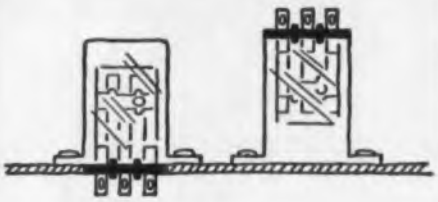
Sparton Corporation, Jackson, Mich., recently dedicated its new southwest military electronics facility at Paradise Hills Industrial Park, Albuquerque, N. M. Guest speaker at the ceremonies was Clinton P. Anderson, U. S. Senator from New Mexico and former U. S. Secretary of Agriculture.

Sparton Southwest, Inc., will concentrate its efforts on the engineering, design and development of highly complex military electronics equipment.

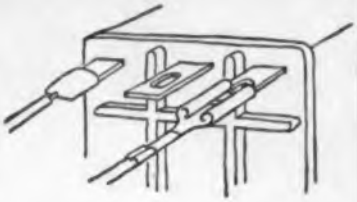
### YIG USEFUL IN MICROWAVE

E. G. Spencer (left) and R. C. LeCraw of Bell Telephone Laboratories operate apparatus used to measure ferromagnetic resonance of yttrium iron garnet (YIG) samples. They have found that YIG has a much sharper resonance peak than any other ferromagnetic material, a property that will make it useful for a number of microwave applications.

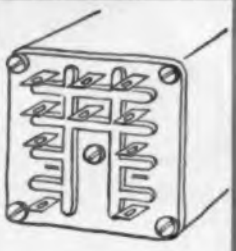
# FRESH IDEAS IN RELAYS...



CHOICE of below-chassis or above-chassis connecting in plastic enclosures.



MULTI-USE terminals allow soldering, insertion in printed circuit board, and use of AMP Style 110 push-on terminals.



ALL TERMINALS on *one* panel... permits insertion in printed circuit board.

**SPECIFICATIONS**

**CONTACTS:** *Integral with terminals;* up to 3PDT; 5 amp, 115 VAC or 32 VDC. Stationary contacts, fine silver inlay material; movable, solid fine silver.

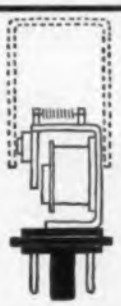
**COILS:** Up to 230 VAC at 60 cps or 115 VDC.

**ENCLOSURES:** Clear plastic.

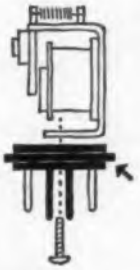
**TERMINAL PANELS:** Barrier type or octal plug.

**LATCHING RELAY:** Available enclosed in clear plastic with plug-in mounting; or unenclosed.

OCTAL PLUG relays up to DPDT have recessed pin bases . . . meet UL spacing requirements to 150 V.



ALL ENCLOSED relays mount solidly on base . . . *not* on covers.



INTEGRAL plug-in base up to DPDT avoids wiring between contact terminals and pins.

# OHMITE'S New "GR" Series

**Stocked for Immediate Delivery From Distributors or Factory...**

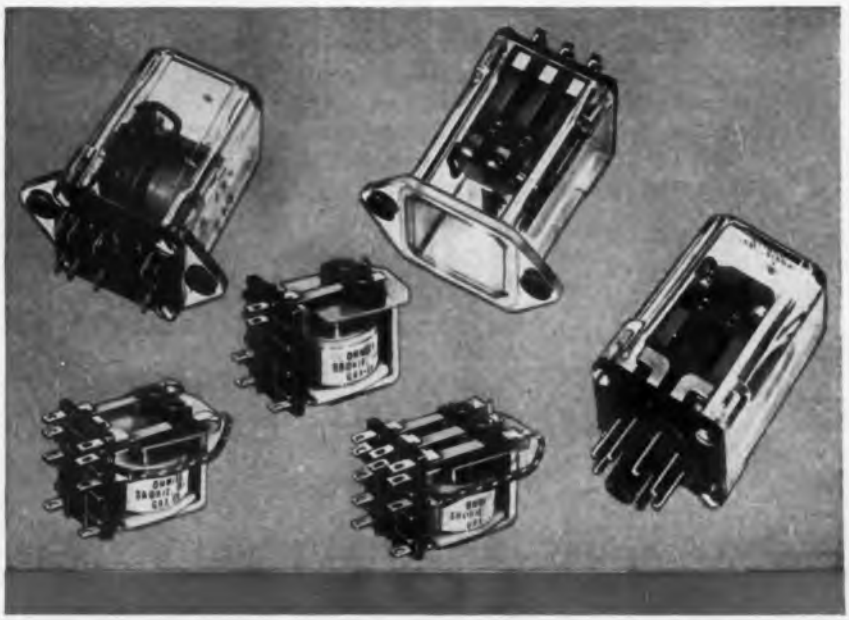
**WRITE FOR BULLETIN 166**

OHMITE

**OHMITE MANUFACTURING COMPANY**

**3662 Howard Street**
**Skokie, Illinois**

Rheostats • Power Resistors
Precision Resistors
Variable Transformers
Tantalum Capacitors • Tap Switches
Micromodules • Relays
R.F. Chokes • Germanium Diodes

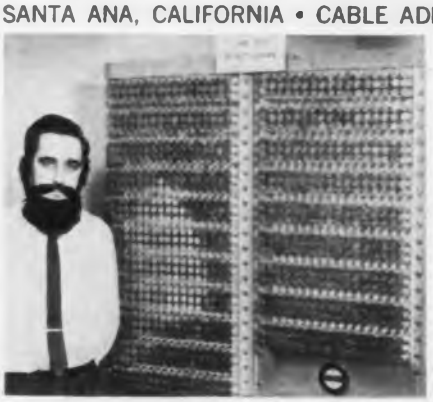


# HOW RELIABLE ARE DIGITAL CIRCUIT MODULES

**IF YOU KNOW THE ANSWER, CAN YOU PROVE IT? ■ Calculations can be misleading ■ Ballyhoo proves nothing ■ Opinions can be biased.** ■ We didn't have an answer, so we took 1,000 of our T-101B Flip-Flop circuit modules – $34,000 worth – from stock and plugged them into a system. Since that time, these units have been operating 24 hours a day at maximum frequency and under heaviest specified load . . . Now we're waiting for a failure. ■ At 1,000,000 hours of operating (1,000 units x 1,000 hours) there were: ■ No infant failures ■ No random failures ■ No wear-out failures ■ Just no failures of any kind. The test is still running. Watch for our next ad. Maybe by then we will have a failure to report. Our Applications Engineering staff stands ready to serve you in implementing your digital systems block diagram. Write, wire, or phone today for further information on any of our families of digital circuit modules or on this life test.

ENGINEERED ELECTRONICS Company

***ENGINEERED ELECTRONICS Company*** 1441 EAST CHESTNUT AVENUE
SANTA ANA, CALIFORNIA • CABLE ADDRESS: ENGELEX



# Coming Events in the electronic industry

Dec. 11-13: Metal Joining Symp., Pennsylvania State Univ., University Park, Pa.
Dec. 13-14: AEEC Winter Mtg.; Hotel Statler, Washington, D. C.
Dec. 18: Wright Brothers Lecture, IAS; Washington, D. C.
Dec. 26-31: Annual Mtg. and Expos. of Science and Industry, American Assoc. for the Advancement of Science; Denver Hilton Hotel, Denver, Colo.
Dec. 27-29: Mtg. of the American Physical Soc.; Los Angeles, Calif.
Dec. 27-30: Annual Mtg. of the American Statistical Assoc.; Roosevelt Hotel, New York, N. Y.
Dec. 28-29: Annual Mtg. of the Pacific Southwest Sec. of the ASEE; Stardust Hotel, Las Vegas, Nev.

## 1962

### JANUARY

Jan. 8-11: 51st Anniversary Conv., Nat'l. Retail Merchants Assoc.; Hotel Statler-Hilton, New York, N. Y.
Jan. 9-11: 8th Nat'l. Symp. on Reliability & Control, IRE, AIEE, ASQC, EIA; Statler-Hilton Hotel, Washington, D. C.
Jan. 15-16: Symp. on Optical Character Recognition, ONR (OSB), NBS (RIC); Dept. of the Interior Auditorium, Washington, D. C.
Jan. 22-24: 30th Annual Mtg. IAS; Hotel Astor, New York, N. Y.
Jan. 22-25: Plant Eng'g. & Maintenance Show & Conf.; Convention Hall, Phila., Pa.
Jan. 23-24: Symp. Prototype & Short Run Tooling Methods, ASME; Barringer Hotel, Charlotte, N. C.
Jan. 23-27: 3rd Annual Conv. & Management Conf., ERA; Hollywood Beach, Hollywood, Fla.
Jan. 24-26: ASME 2nd Symp. on Thermophysical Properties; Princeton Univ., Princeton, N. J.
Jan. 29-Feb. 2: Winter General Mtg. & Electrical Eng'g. Expos., AIEE; New York Coliseum, New York, N. Y.
Jan. 30-Feb. 2: 18th ANTEC, Pittsburgh Sec. SPE; Penn-Sheraton Hotel, Pittsburgh, Pa.

### FEBRUARY

Feb. 5-9: ASTM Committee Week; Statler-Hilton and Sheraton-Dallas Hotels, Dallas, Tex.
Feb. 6-7: Symp. on Redundancy Techniques for Computing Systems, ONR (ISB); Dept. of the Interior Auditorium, Washington, D. C.
Feb. 7-8: Automatic Production-Numerical Control, ASTME; Statler-Hilton Hotel, Cleveland, Ohio.
Feb. 7-9: 1962 Winter Conv. on Military Electronics, IRE (PGME) L. A. Sec.; Ambassador Hotel, Los Angeles, Calif.
Feb. 9-11: Pacific Electronic Trade Show; Shrine Auditorium, Los Angeles, Calif.

**Highlights of '61**

Dec. 12-14: 1961 Eastern Joint Computer Conf. AFIPS, IRE (PGEC), AIEE, ACM; Sheraton Park Hotel, Washington, D. C.

Feb. 15-16: 9th Annual Int'l. Solid-State Circuits Conf., IRE, AIEE, U. of Pa.; Sheraton Hotel and Univ. of Pa. Campus, Phila., Pa.
Feb. 18-22: Electrical Insulation Conf. —Materials and Application, AIEE, NEMA, ASTM, SPE; Shoreham Hotel, Washington, D. C.
Feb. 19-21: Range Reconnaissance & Tracking of Aero-Space Vehicles, IAS; San Francisco, Calif.

### MARCH

Mar. 1-3: 8th Scintillation & Semiconductor Counter Symp., IRE (PGNS), AIEE, AEC, NBS; Shoreham Hotel, Washington, D. C.
Mar. 4-8: ASME Gas Turbine-Process Industries Conf.; Shamrock-Hilton Hotel, Houston, Tex.
Mar. 6-7: 5th Annual Tech. Conf. of the Soc. of Vacuum Coaters; Sheraton-Cleveland Hotel, Cleveland, Ohio.
Mar. 7-8: Prototype and Short Run Tooling Methods, ASTME; Statler-Hilton Hotel, Dallas, Tex.
Mar. 8-9: Flight Propulsion Mtg., IAS; Cleveland, Ohio.

**Highlights '62**

IRE Internat'l. Conv., Mar. 26-29, Coliseum & Waldorf-Astoria Hotel, New York, N. Y.
WESCON, Aug. 21-24, IRE, WEMA; Los Angeles, Calif.
Nat'l. Electronics Conf., Oct. 9-11, IRE, AIEE, EIA, SMPTE; Chicago, Ill.
NEREM (Northeast Res. & Eng. Mtg.) Nov. 13-15, IRE; Boston, Mass.

Mar. 10-13: Int'l. Watchmakers and Mechanical Instrumentation Cong.; Hotel Commodore, New York, N. Y.
Mar. 14-16: EIA Mtg.; Statler-Hilton Hotel, Washington, D. C.
Mar. 14-16: 12th Annual Conf. on Instrumentation for the Iron & Steel Industry, ISA; Hotel Roosevelt, Pittsburgh, Pa.
Mar. 20-25: 1962 Los Angeles High Fidelity Music Show, IHFM; Ambassador Hotel, Los Angeles, Calif.
Mar. 22-24: Radio Tech. Comm for Marine Services (RTCM) Assembly Mtg.; Claridge Hotel, Atlantic City, N. J.
Mar. 27-29: American Power Conf., ASME; Sherman Hotel, Chicago, Ill.
Mar. 28-29: Carbide and Ceramic Tooling, ASTME; Conrad Hilton Hotel, Chicago, Ill.
Mar. 28-31: 11th Biennial Electrical Industry Show, EMEA of Calif.; Shrine Exposition Hall, Los Angeles, Calif.

### 1962 INTERNATIONAL

Feb. 16-20: 5th Int'l. Electronic Components Exhibition, Parc Des Expositions, Porte De Versailles, Paris.
Apr. 10-11: Railroad Conf., ASME, AIEE; King Edward Hotel, Toronto, Ont., Canada.
Apr. 28-May 5: 2nd Int'l. Exhibition of Television Equipment; Montreux, Switzerland.
June 10-15: Summer Annual Mtg. ASME; Hotel Frontenac, Quebec, Canada.
June 25-30: Symp. on Electromagnetic Theory and Antennas; The Technican Univ. of Denmark, Copenhagen, Denmark.
Aug. 27-Sept. 1: 2nd Int'l. Cong. of Information Processing; Munich, Germany.
Aug. 27-Sept. 1: 3rd Int'l. Cong. ICAS; Stockholm, Sweden.
Oct. 22: Plastics vs. Corrosion, Ontario Sec. SPE; Toronto, Ont., Canada.
Oct. 22-23: CIA/IAS Mtg.; King Edward Hotel, Toronto, Ont., Canada.
Nov. 12-14: Radio Fall Mtg., IRE (PGBTR), RQC, ED, EIA; King Edward Hotel, Toronto, Int., Canada.

### CALL FOR PAPERS

6th Nat'l. Conv. on Military Electronics (MIL-E-CON 1962), June 25-27, 1962, Washington, D. C. Papers presenting original work in military electronics are invited. Deadline for following information: Feb. 1, 1962: 3 copies, 750-word unclassified abstract of paper, name and position of author, name of company or organization. 3 copies of biographical sketch. Each author must obtain appropriate military and company

(*Continued on page* 12)

# Coming Events

(*Continued from Page* 11)

clearances for his abstract. Send to: Mr. J. J. Slattery, F316, The Martin Co., Baltimore 3, Md.

**1962 Int'l. Symp. on Information Theory, Sept. 3-7, 1962, Brussels, Belgium.** Some typical topics: Human Operators; Linguistics; Pattern recognition, learning, adaptive filters; Analyses and design of communication and detection systems. **Deadline** for 500-1000 word abstracts: **Jan. 15, 1962.** Deadline for full length papers: **April 15, 1962.** Send to: Dr. F. L. Stumpers, Philips Research Laboratories, Eindhoven, Netherlands.

**10th Conf. on Electromagnetic Relays, Apr. 24-26, 1962, Oklahoma State Univ. Campus. Deadline** for authors name, title, name of Company and title of paper: **Jan. 15, 1962.** Deadline for paper. Mar. 1, 1962. Send to: Prof. C. F. Cameron, School of Electrical Eng'g., Oklahoma State Univ., Stillwater, Okla.

**1962 PGMTT Nat'l. Symp., May 22-24, 1962, Boulder Labs., Boulder, Colo.** Papers to deal with research development and applications in all areas of the microwave field. **Deadline: Dec. 18, 1961** for both 50-100 word abstracts and 500-1000 word summaries with up to 6 illustrations. Forward to: R. W. Beatty, Chairman, Technical Program Committee, 1962 PGMTT Nat'l. Symp., National Bureau of Standards, Boulder, Colo.

**1962 Internat'l. Congress on Human Factors in Electronics, May 3-4, Lafayette Hotel, Long Beach, Calif.** Papers to deal with human factors in Automatic Control, Biological Science, Communications, Computers, Cybernetics, Electrical Engineering, Information Theory, Mathematics, Medicine, and Psychology are solicited. Send 2 copies of an abstract of 300 words. **Deadline: Jan. 1, 1962,** to Mr. John W. Senders, Technical Program Committee Chairman, Minneapolis - Honeywell Regulator Co., 2600 Ridgeway Rd., Minneapolis 40, Minn.

## ENGINEERING EDUCATION

*Short courses of interest to electronic engineers.*

**Management**

**University Extension, University of California, Los Angeles 24, Calif.** offering an intensified 10 day short course "Engineering and Management." Aim: To prepare individuals for more effective design, installation and administration of systems coordinating men, materials, machines and money. **Date: Jan. 22 - Feb. 1.** Further information available from Reno Cole, coordinator of the course, at the above address.

## New

# Corning CYFM Capacitor has reliability you can see

You get total protection against environment for less money than ever before

The new Corning CYFM capacitor gives you reliability at a markedly lower cost than that of any like capacitor.

The CYFM goes far beyond MIL-C-11272B specs. It has proved its performance through more than 3,000,000 hours of testing. It took a 50-day MIL moisture test and a 96-hour salt spray test with no measurable effects. We stopped testing only when it became evident that no more significant data could be developed. The CYFM went through other tests, with solvents, fluxes, boiling salt, and steam, to make sure it is the most completely sealed capacitor you can buy.

You'll see why the CYFM can take such torture when you check its design. We stack alternate layers of stable ribbon glass and aluminum foil. Then we weld the foils to the bead-terminal assembly, which has a glass bead sealed to the Dumet wire lead. With heat and pressure, the entire capacitive element is frozen in glass for complete protection against environment and for structured protection against physical shock.

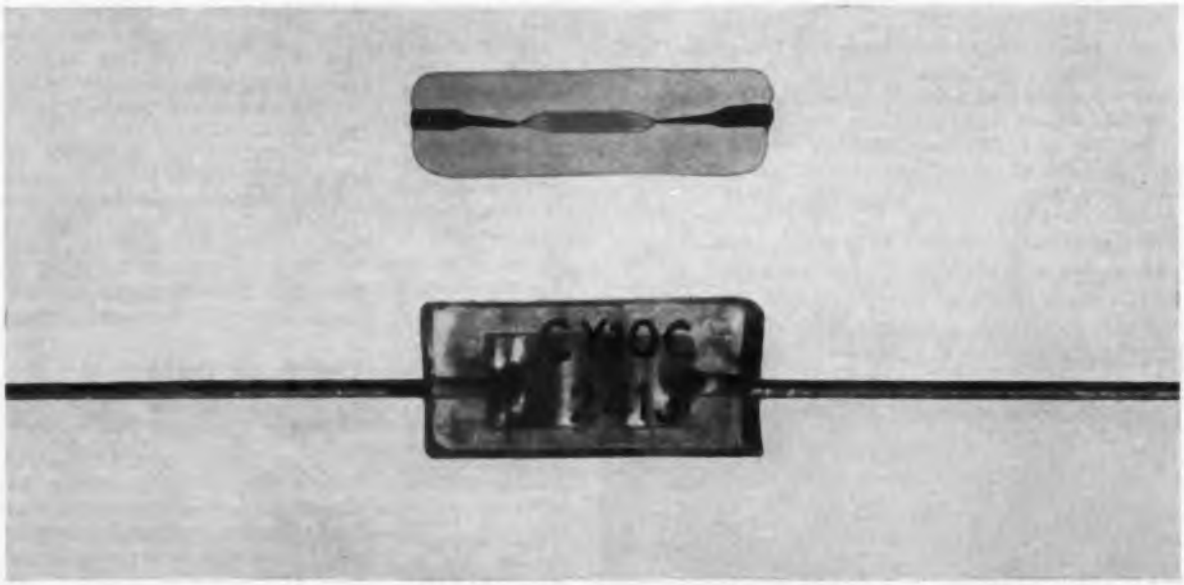
True glass-to-metal seals at the weld area and along the leads bar moisture. The seal of the leads to the glass shifts stresses from the leads to the entire monolithic unit, guarding the capacitance area. Of course, you get electrical performance to match this environmental stability, since the CYFM has our glass-foil capacitor construction.

The CYFM is machine made . . . each capacitor is the same as every other, to give you uniformity which hand production cannot match.

You can get immediate delivery on the CYFM in four types. The CYFM-10 gives capacitance values from 0.5 to 300 $\mu$f; the CYFM-15, from 220 to 1200 $\mu$f; the CYFM-20, from 560 to 5100 $\mu$f, and the CYFM-30, from 3600 to 10000 $\mu$f.

For the rest of the story on this capacitor, send for our data sheet. Write to Corning Glass Works, 548 High Street, Bradford, Pa.

**Corning Glass Works**
Service through research



This is the CYFM capacitor. 6 times actual size. The dark areas between the ends of the glass and the capacitance element are your visual proof of the complete glass-to-metal seal.

CORNING

# As We Go To Press . . .

### "TV SCOOTER"

Key equipment in closed circuit TV system at the Pioneer Bank & Trust Co., Shreveport, La., is the "TV scooter." Scooter moves on tracks in front of the bank files and transmits TV pictures to monitors in the main and branch banks. Installation is manufactured by Dage Div. of Thompson Ramo Wooldridge, Michigan City, Ind.

## *Companies Merge*

All activities of Dynacor, Inc. of Rockville, Md., manufacturers of magnetic tape core materials, have been merged with the Sprague Electric Co., of which Dynacor has been a wholly owned subsidiary.

Engineering and manufacturing operations will continue in the present facilities at Rockville. Sales engineering and customer contacts will be handled by the nationwide Sprague sales organization, with headquarters in North Adams, Mass.

## *Lunar Vehicle Earth Controlled*

A robot vehicle, designed to map and analyze the lunar surface prior to landings by manned spacecraft has been designed by the Airborne Instruments Laboratory Division of Cutler-Hammer, Inc., Deer Park, L. I., N. Y.

The vehicle was designed to provide lunar data. AIL scientists believe that robot lunar study programs are necessary prior to any manned lunar expedition.

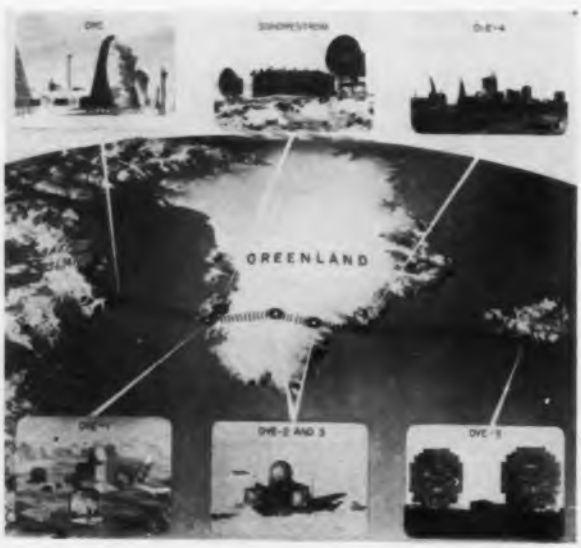
The robot vehicle will explore the lunar regions of interest, sample surface materials, provide pictures of the area, map the region, collect data on the environment, and perform other exploratory functions, all of which will provide information essential to the safety of future manned lunar expeditions.

## *Fuel Cell Agreement*

An agreement has been signed for the exchange of research information and for future cooperative development of fuel cells by The Electric Storage Battery Co. and Sun Oil Co.

Fuel cells, unlike conventional electric batteries, convert chemical energy directly into electricity. They do this without a "heat energy" cycle and at a higher efficiency than is possible with internal combustion or steam engines and stationary power plants.

The greatest potential for fuel cells at the present time lies in portable applications having moderate electrical requirements.




### DEW LINE

Recently completed Eastern segment of the DEW Line stretches about 1,200 miles from Baffin Island, across southern Greenland and the Denmark Strait to Iceland. It includes seven communications and radar detection sites. Western Electric was prime contractor for the project's electronic engineering installation, and testing.

### S.A.M. CITATION

"Professional Manager" Citation for 1961 is presented by J. E. Newsome (l), Board Chairman of The Society for Advancement of Management, to S. N. Shure, president of Shure Brothers, Inc., Evanston, Ill. The electronics executive was honored as a "leader in the field of demonstrating sound application of scientific and advanced management principles."

## *Network to Link Turkey, Iran & Pakistan*

International Cooperation Administration (ICA) has awarded RCA a $16,400,000 contract for a 3,060-mile telecommunications network linking Turkey, Iran and Pakistan.

Described as an important part of the U. S. Mutual Security program, the network will extend from Ankara, Turkey, as the westernmost terminus, to Teheran, and thence to Karachi thus connecting the three host country capitals. When completed, the network will be turned over by the ICA to the host countries.

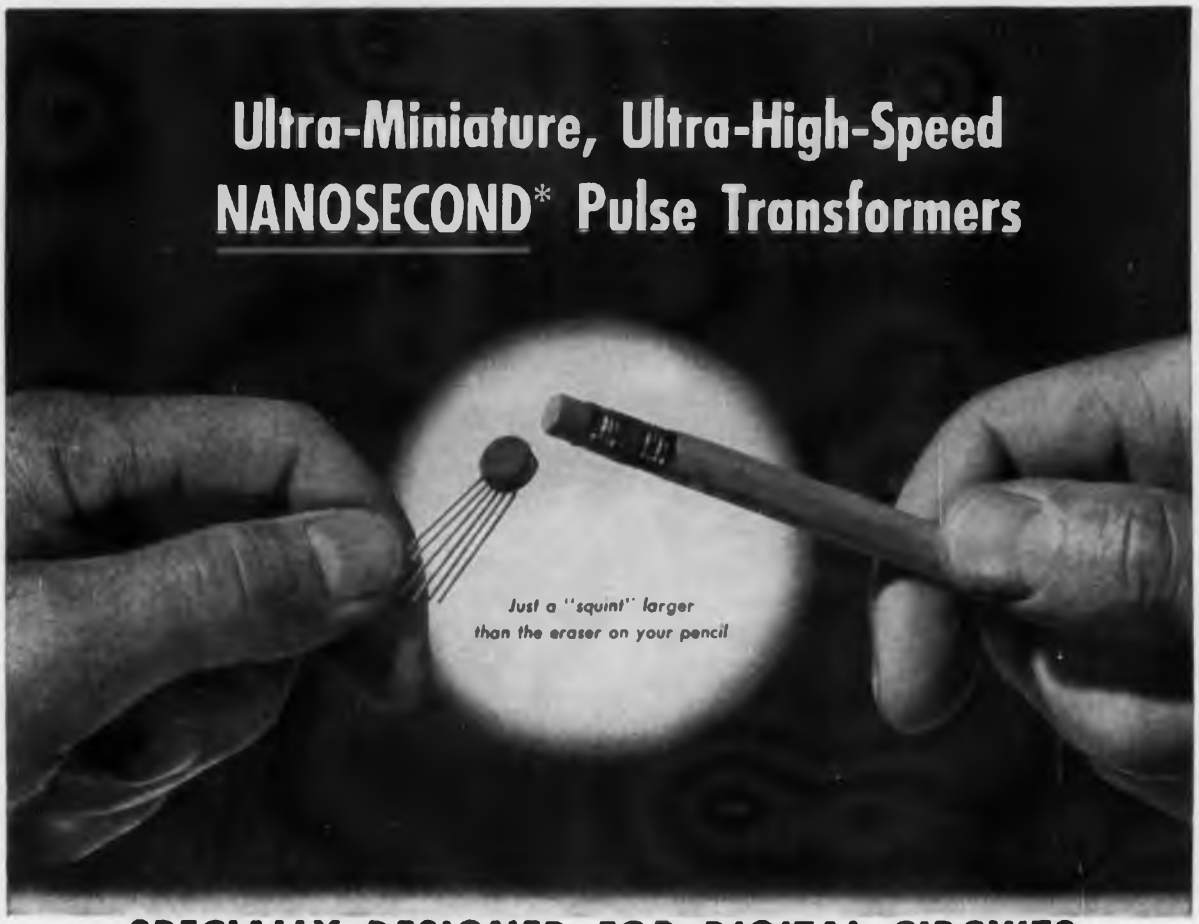
The system will be known officially as the CENTO Telecommunications Network, taking its name from the Central Treaty Organization of which Turkey, Iran, Pakistan and the United Kingdom are members. The U. S. has bilateral agreements with the host countries.

## *Electronic Gate System Installed*

A General Electric Co. custom-designed closed circuit television and electronic gate system has been installed at Pittsburgh Plate Glass Company's Chemical Division plant at Lake Charles, La. It will provide remote surveillance and regulation of an entrance to a critical plant area.

The system's camera, mounted on a special pole 40 feet from the gate, is operated remotely from a custom-built control unit in the guardhouse a quarter of a mile away. PPG designed and engineered the control console.

# Ultra-Miniature, Ultra-High-Speed NANOSECOND* Pulse Transformers




## SPECIALLY DESIGNED FOR DIGITAL CIRCUITS AND OTHER TRANSISTORIZED APPLICATIONS

Here's the new Sprague Type 43Z Nanosecond Pulse Transformer! Almost unbelievably tiny, it's specially designed for digital and other low-level transistorized circuits. Scrupulously engineered, too, for the all important parameter of minimum rise time at high repetition rates up to 10 mc.

Type 43Z Pulse Transformers are designed to hold the product of leakage inductance and distributed capacitance at a minimum. Consequently, you'll find them especially appropriate for transformer coupling in transistor circuits (since transformers and transistors are very compatible low impedance devices). You'll also find Nanosecond Pulse Transformers equally suitable for transmission line mode of operation, for twisted-pair transmission line coupling, for narrow pulses with small differentiating time constants, and regenerative circuits as well.

Circuit designers find the epoxy-encapsulated "pancake" package ideal for both etched wire board and conventional chassis mounting. To simplify etched-board design, these ultra-miniature pulse transformers are available with leads terminating at the side or at the bottom of each unit.

*Standard ratings for new Type 43Z Series include a broad line of 72 pulse transformers in 10 popular turns ratios. For complete technical information on Type 43Z Nanosecond Pulse Transformers, write for Engineering Data Sheet 40235 to Technical Literature Section, Sprague Electric Co., 233 Marshall St., North Adams, Massachusetts.*

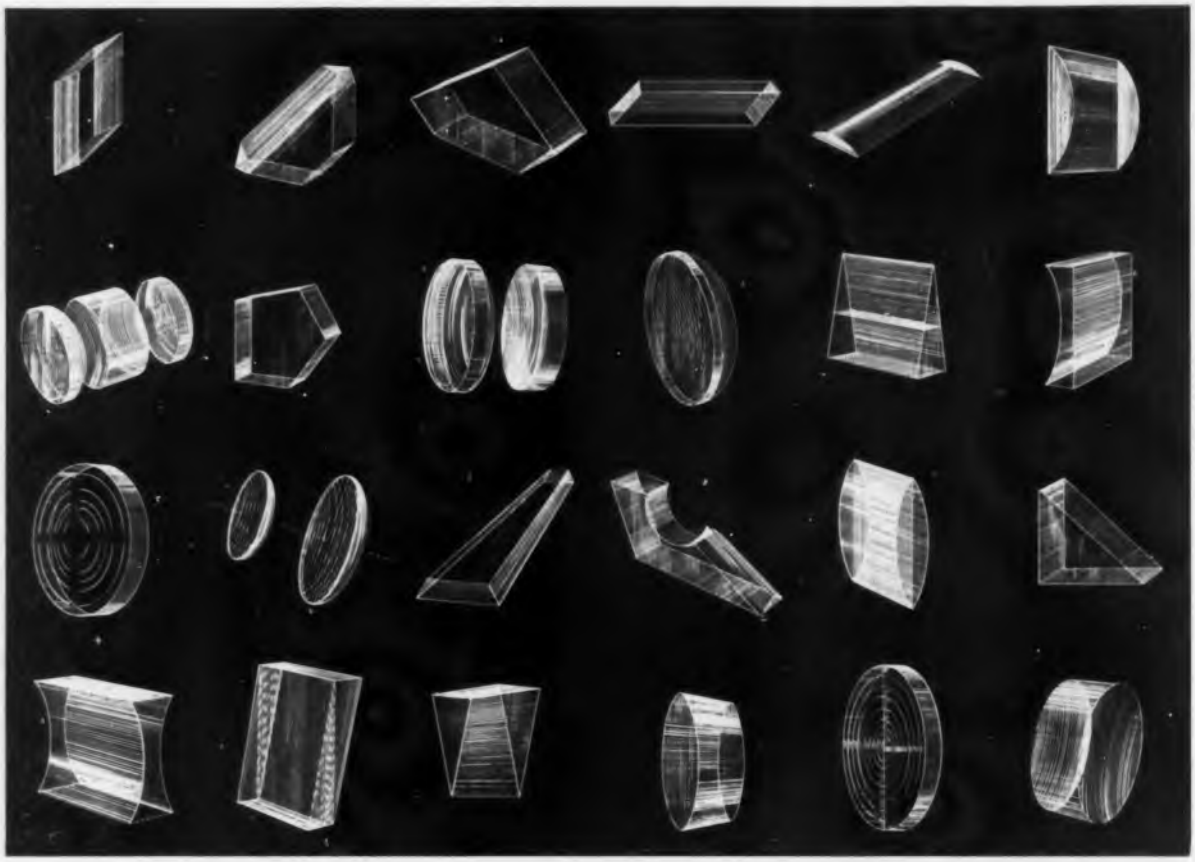
*millimicrosecond

**SPRAGUE COMPONENTS**

| | | |
|---|---|---|
| PULSE TRANSFORMERS | INTERFERENCE FILTERS | HIGH TEMPERATURE MAGNET WIRE |
| CAPACITORS | MAGNETIC COMPONENTS | CERAMIC-BASE PRINTED NETWORKS |
| TRANSISTORS | PIEZOELECTRIC CERAMICS | PACKAGED COMPONENT ASSEMBLIES |
| RESISTORS | PULSE-FORMING NETWORKS | FUNCTIONAL DIGITAL CIRCUITS |

**SPRAGUE**
*THE MARK OF RELIABILITY*

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



# OPTICS FOR ELECTRONICS . . .

**Components and systems for visible, ultraviolet, and infrared radiation.** GEC's Astro-Optics Division specializes in design, development, and manufacturing of optical components and systems for the ultraviolet through infrared spectrum.

Here are a few of the optical components you can order from Astro-Optics: prisms, flats, spherical, aspherical and parabolic surfaces, reticles, information choppers, encoders, precision vacuum coating, and optically polished synthetic crystals.

Also available from Astro-Optics are infrared and optical-electronic systems.

For complete information regarding your precision optical requirements, write today to:

**ASTRO OPTICS DIVISION**

*. . . precision optics at work*

**GENERAL ELECTRODYNAMICS CORPORATION**

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Circle 7 on Inquiry Card

Circle 8 on Inquiry Card

# Centralab®

*introduces*

four styles of

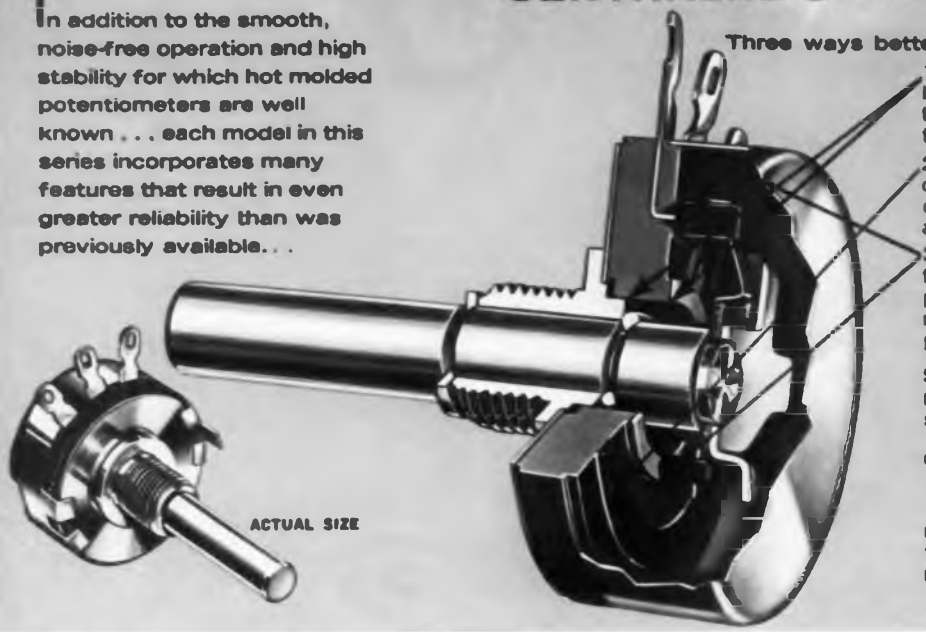
**HOT MOLDED CARBON POTENTIOMETERS**

For smooth, noise-free operation and high stability . . . The widest selection anywhere . . . Designed to meet MIL-R-94 environmental and test requirements

*Centralab . . . producer of carbon potentiometers for over 35 years*

# CENTRALAB'S MODEL A (RV4 Style)

In addition to the smooth, noise-free operation and high stability for which hot molded potentiometers are well known . . . each model in this series incorporates many features that result in even greater reliability than was previously available. . .




**Three ways better than other hot molded units**

1. Greatly increased high voltage capability, due to the wide clearance between the bushing and the collector track.
2. Greater freedom from contamination of dirt, carbon particles and sealing compounds, due to the elevated resistance track construction.
3. Exceptionally long noise free operation that actually improves with use, provided by the carbon composition material of which both the collector and pick-off brushes are constructed.

### SPECIFICATIONS:

**RATING:** 2 watts at 70° C.

**SIZE:** 1-3/32" diameter, 37/64" deep from mounting surface.

**CONSTRUCTION:** Completely enclosed. All metallic parts are non-magnetic and corrosion resistant. Available in tandem, triple or dual concentric construction.

**ROTATION:** 312° ±3°.

**TORQUE:** 1.0 to 6.0 ounce inches

**RESISTANCES:** Linear taper, 50 ohms to 5 MEG. Log taper, 100 ohms to 2.5 MEG.

## MODEL N

This intermediate size potentiometer has never before been offered. Rated at ¾ watt, the Model "N" can replace 2 watt units in many military and commercial applications where size is important.

A flush resistance track is protected against contamination by the raised rim of the insulating base. Although small in size, the model "N" also has carbon composition pick up and collector brushes for long,noise-free operation.

The one-piece metal case and bushing is spun over the molded insulating base to provide a near-perfect seal. Triple shaft seals and water-tight panel seals can be supplied.

### SPECIFICATIONS:

**RATING:** 3/4 watt at 70° C.

**SIZE:** 23/32" diameter, 1/2" deep from mounting surface.

**CONSTRUCTION:** Completely enclosed. All metallic parts are non-magnetic and corrosion resistant.

**ROTATION:** 300° ±3°

**TORQUE:** 5.0 ounce inches average.

**RESISTANCES:** Linear taper, 50 ohms to 5 MEG. Log taper, 100 ohms to 2.5 MEG.

## MODEL P (RV6 Style)

Although much smaller than the Model "N", the Model "P" is rated at ½ watt and is similar in external construction.

The resistance track is hot molded, flush type. An outstanding feature of the Model "P" is the single carbon brush that serves both collector and pick-off purposes. The one-piece aluminum case is spun over the insulating base to provide a near-perfect seal.

This unit meets all applicable military requirements.

### SPECIFICATIONS:

**RATING:** 1/2 watt at 70° C.

**SIZE:** 1/2" diameter, 15/32" deep from mounting surface.

**CONSTRUCTION:** Completely enclosed.

**ROTATION:** 290° ±3°.

**TORQUE:** 1.5 ounce inches.

**RESISTANCES:** Linear taper, 100 ohms to 5 MEG. Log taper, 500 ohms to 2.5 MEG.

## MODEL T

This unique trimmer resistor, or locking-type trimmer potentiometer, is the only hot molded, single turn unit available on today's market. Rated at ⅓ watt, it has been designed primarily for printed-circuit board applications.

The Model "T" has a positive screw actuated lock and is extremely resistant to shock, vibration and acceleration.

These units can be encapsulated in a rigid resin without damage.

### SPECIFICATIONS:

**RATING:** 1/3 watt at 70° C.

**SIZE:** 19/32" diameter, 11/32" deep from mounting surface.

**CONSTRUCTION:** Open (however, rugged construction permits potting of all types).

**ROTATION:** 300° ±3°.

**TORQUE:** Locking type.

**RESISTANCES:** Linear taper, 500 ohms to 5 MEG.

***IMMEDIATE DELIVERY FROM STOCK***

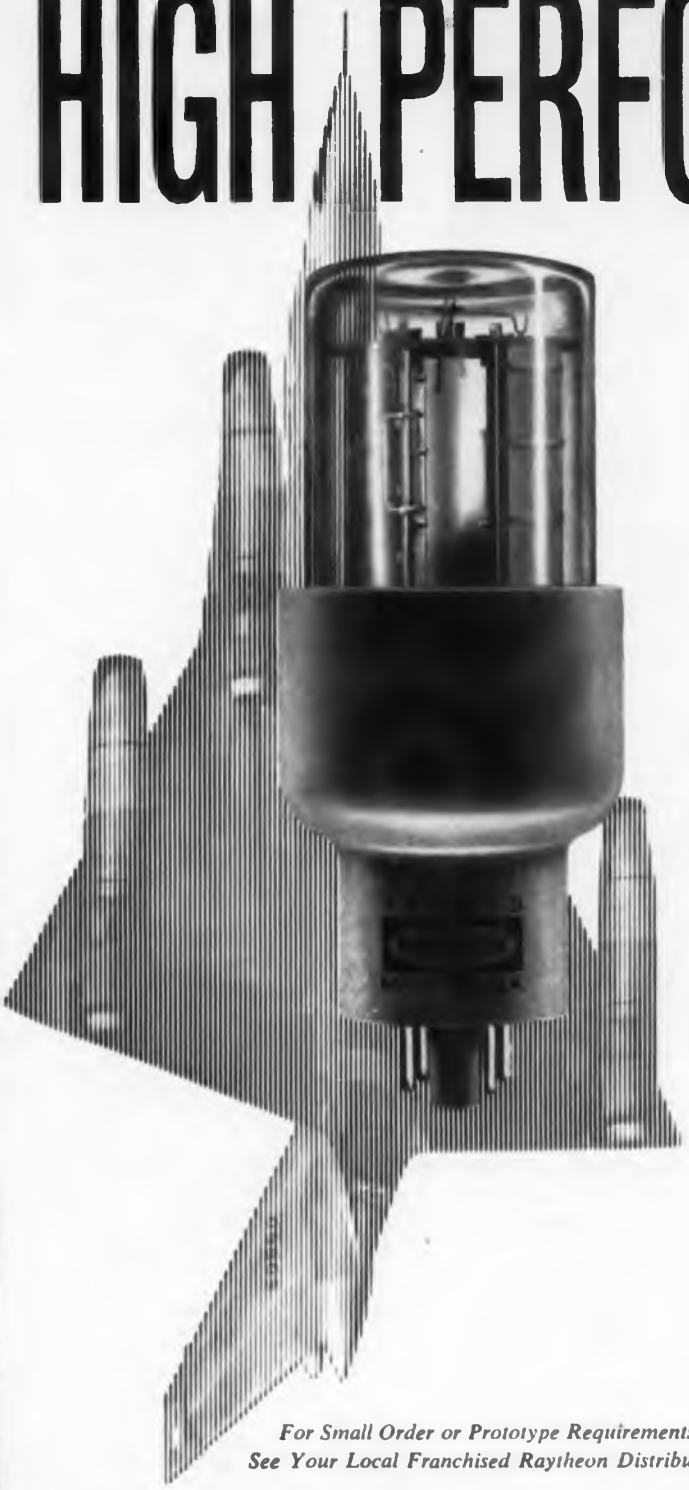
**A full range of values of all four types of Centralab hot molded carbon potentiometers are available in quantity, from stock, through Centralab industrial distributors.**

**Centralab**

THE ELECTRONICS DIVISION OF GLOBE UNION INC.
900 E. KEEFE AVENUE • MILWAUKEE 1, WISCONSIN
In Canada: Centralab Canada Ltd., P.O. Box 400, Ajax, Ontario

CIRCLE 103 ON READER SERVICE CARD

# HIGH PERFORMANCE!



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

**Raytheon now offers the 5R4WGB full-wave rectifier — ideal for high-current, high-PIV power supply requirements in rugged environments.**

The reliability of Raytheon 5R4WGB rectifiers is the result of exceptional care in their design and manufacture . . . with no compromise in quality control. Rubber lined bases and hard glass T-14 bulbs protect against severe shock and vibration. Raytheon 5R4WGB rectifiers are specifically designed for rugged industrial and military applications and fully conform to all applicable military specifications.

If you design power supplies or communications equipment, you will be interested in receiving full technical data on the 5R4WGB . . . and other types in Raytheon's expanding line of diode rectifiers.

Please write to: Raytheon, Industrial Components Division, 55 Chapel Street, Newton 58, Massachusetts.

**RAYTHEON DIODE RECTIFIERS**

| TYPE | SERVICE | HEATER | | MAX. PLATE RATINGS | | |
|---|---|---|---|---|---|---|
| | | VOLTS | AMPS. | PEAK INVERSE (VOLTS) | PEAK CURRENT (AMPERES) | AVERAGE CURRENT (AMPERES) |
| 5R4WGB* | FULL WAVE RECTIFIER | 5.0 | 2.075 | 2,[illegible]<br>2,900<br>2,300<br>2,150<br>2,[illegible] | .7 | 0.165<br>0.190<br>0.275<br>0.275<br>0.275 |
| 583* | H.W. RECT. (to 36,000 ft.)<br>CLIPPER DIODE (to 36,000 ft.) | 2.5<br>2.5 | 4.9<br>4.9 | 17,000<br>15,000 | 0.250<br>8.0 | 0.065<br>0.240 |
| 3B24W<br>3B24WA* | H.W. RECT. (HALF FIL.)<br>(FULL FIL.) | 2.5<br>5.0 | 3.0<br>3.0 | 20,000<br>20,000 | 0.150<br>0.300 | 0.030<br>0.060 |
| 3B26 | CLIPPER DIODE | 2.5 | 4.75 | 15,000 | 8.0 | 0.020 |
| 3B29 | H.V. RECT. (OP. 1)<br>(OP. 2)<br>(OP. 3)<br>CLIPPER DIODE | 2.5<br><br><br>2.5 | 4.9<br><br><br>4.9 | 16,000<br>7,700<br>5,000<br>10,000 | 0.250<br>0.300<br>0.300<br>8.0 | 0.065<br>0.080<br>0.095<br>0.018 |
| 4B31* | H.W. RECT.<br>CLIPPER DIODE | 5.0<br>5.0 | 5.0<br>5.0 | 16,000<br>16,000 | 0.470<br>12.0 | 0.150<br>0.060 |

*Mil-Std-200E Preferred Type

RAYTHEON COMPANY

INDUSTRIAL COMPONENTS DIVISION

RAYTHEON

COAXIAL CABLE SPLICE...

# THERMOFIT

**This premolded encapsulating coaxial cable splice shrinks in seconds on exposure to 275°F. quickly and inexpensively accomplishing a moisture-tight seal. It is one example of a wide variety of standard molded Thermofit configurations available from stock in four different rubber and plastic materials. Any moldable configuration is available with short lead time. Parts will shrink to as little as 20% of the original diameter.**

RAYCLAD TUBES
INCORPORATED

A SUBSIDIARY OF
RAYCHEM
CORPORATION

OAKSIDE AT NORTHSIDE • REDWOOD CITY • CALIFORNIA

# News Briefs

*Capsule summaries of important happenings in affairs of equipment and component manufacturers*

## EAST

**MICROWAVE ASSOCIATES, INC.**, Burlington, Mass., has been awarded a contract in excess of $300,000 from **WESTERN UNION TELEGRAPH CO.** for microwave tubes. The tubes will be used in Western Union's transcontinental microwave beam system consisting of 270 stations from Los Angeles and San Francisco to New York and Boston.

**The J. W. FECKER DIV., AMERICAN OPTICAL CO.**, has received a $1,077,404 contract from **SPERRY CO.'S MARINE DIV.** to develop two tracking optical telescopes for the Air Force's Mobile Atlantic Range Station. The telescopes, which will photograph the reentry of missile and space vehicles, will be mounted aboard two ships now being converted into floating observation stations.

**HI-G, INC.**, Windsor Locks, Conn., has announced a $250,000 building expansion plan which will double their present production space to 46,000 sq. ft.

**RAYTHEON CO., AERO/WEAPONS DIV.**, Andover, Mass., has been awarded a $1,967,000 contract by the Army Boston Ordnance District for the production of high power radar illuminators for the Hawk missile system.

The Air Force has awarded **ARMA DIV., AMERICAN BOSCH ARMA CORP.**, Garden City, N. Y., an incentive contract valued at $17,600,000 for additional inertial guidance systems for USAF ATLAS ICBM's.

**BULOVA WATCH CO.'S RESEARCH AND DEVELOPMENT LABORATORIES**, Woodside, N. Y., has received letter contracts approximating $1 million for initial production of a new type of igniter safing- and arming-system designed to turn on all three engines of the USAF's Minuteman ICBM. The negotiated contract is between Bulova; the USAF; **THIOKOL CHEMICAL CORP.**, Brigham City, Utah; **AEROJET GENERAL CORP.**, Sacramento, Calif., and **HERCULES POWDER CO.**, Magma, Utah.

**CORNING GLASS WORKS**, Bradford, Pa., has started construction on a 120,000 sq. ft. electronic components plant at Raleigh, N. C. The plant is expected to be in operation next summer.

The consolidation of **MARTIN CO.** and **AMERICAN-MARIETTA CO.** has been approved by the stockholders. Martin stockholders will receive 1.3 shares of common stock in **MARTIN-MARIETTA** for each share presently held, and American-Marietta common stockholders will receive a share-for-share exchange.

**TECHNICAL WIRE PRODUCTS, INC.**, has completed its new plant at 129 Dermody St., Cranford, N. J. The 10,000 sq. ft. plant is twice the size of their former headquarters in Springfield, N. J.

**ADLER ELECTRONICS INC.**, New Rochelle, N. Y., has received additional contracts valued at $1.5 million for the design and production of air and ground transportable area communications systems. The contracts were awarded by **GENERAL DYNAMICS/ELECTRONICS.**

**ELECTRONIC INSTRUMENT CO., INC. (EICO)**, Long Island City, N. Y., is establishing a Space Age Hall of Fame, designed to encourage and stimulate interest in activities in the world of space and to pay tribute to the men and women who have contributed to the development of space. Four people will be elected bi-annually to the Space Age Hall of Fame.

**MAXSON ELECTRONICS CORP.**, New York, N. Y., has been awarded a contract amounting to $444,427.85 by the Bureau of Naval Weapons for the production of Adaption Kits for the TALOS missile.

A design, engineering and installation contract in excess of $200,000 has been awarded to the **TECHREP DIV., PHILCO CORP.**, Phila., Pa., for expansion of the U. S. Navy's Norfolk, Va., Communications Center.

**TRACERLAB, INC.**, Waltham, Mass., has been merged into **LABORATORY FOR ELECTRONICS, INC.**, Boston, Mass. LFE has issued 161,287 shares of common stock in exchange for the outstanding shares of Tracerlab. Tracerlab will operate under its own name as a division of LFE.

**SYLVANIA ELECTRIC PRODUCTS, INC., DATA SYSTEMS OPERATIONS**, Needham, Mass., has received a $100,000 USAF award for the study of space flight simulation.

**INTERNATIONAL TELEPHONE AND TELEGRAPH CORP.**, New York, N. Y., has announced a plan for the acquisition of the remainder of the outstanding stock of its 56.55% owned subsidiary, American Cable & Radio Corp. The plan calls for stockholders of American Cable & Radio to receive $4 of ITT convertible preferred stock and 1/7 of a share of ITT capital stock for each share of American Cable & Radio.

**RCA's SURFACE COMMUNICATIONS DIV.**, Defense Electronic Products, Camden, N. J., has received a 1-year $183,000 study contract from the U. S. Army Signal Supply Agency, Phila., Pa., to develop a maintenance and logistics program for Micro-Module equipment.

New 115,000 sq. ft. headquarters building and Applied Research Laboratory facility has been formally dedicated by Sylvania Electronic Systems, Div. of Sylvania Electric Products Inc., on a 55-acre site at Waltham, Mass.

## MIDWEST

**MOTOROLA, INC.**, Chicago, Ill., has been awarded two contracts by the Navy totaling $6.3 million for the construction of Sonobuoys.

**CLEVITE TRANSISTOR, DIV. OF CLEVITE CORP.**, Waltham, Mass., has announced the opening of a sales office at 19802 Mack Ave., Detroit 26, Mich.

**ELGIN NATIONAL WATCH CO.**, Elgin, Ill., has received new orders for government missile work. The four contracts totaling $4,035,000 cover production work on Bullpup, Sparrow, Sidewinder and Tartar.

**MIRATEL ELECTRONICS, INC.**, New Brighton, Minn., has purchased all outstanding shares of stock of **MID AMERICA RELAYS SYSTEMS, INC.**, Rapid City, S. Dak. Mid America will operate as a subsidiary of Miratel.

**COLLINS RADIO CO.**, Cedar Rapids, Ia., has received an order for Horizontal Situation Indicator equipment from McDonnell Aircraft Corp., St. Louis, Mo., totaling approximately $765,600. The equipment will be used on McDonnell's F4H Phantom.

Continental Electronics Mfg. Co., sub. of Ling-Temco-Vought, Inc., is adding 14,500 sq. ft. to its headquarters building at 4212 So. Buckner Blvd., Dallas, Tex.

## WEST

**CONSOLIDATED ELECTRODYNAMICS CORP., SUB. OF BELL & HOWELL CO.**, Pasadena, Calif., has received a contract in excess of $475,000 from **INTERSTATE ELECTRONICS CORP.**, for magnetic recorder/reproducers VR-2600 PCM systems for use in the Polaris program.

**PACKARD BELL ELECTRONICS**, Los Angeles, Calif., has received a $500,000 extension contract to produce airborne recorders for use in Anti-Submarine Warfare from the U. S. Navy Bureau of Weapons.

**GENERAL ELECTRIC'S TEMPO**, Santa Barbara, Calif., has received a contract of $211,500 from the Defense Atomic Support Agency to establish an information center on the subject of high-altitude nuclear effects. The center is for the use of government, industrial, and academic research workers throughout the nation.

**RAYTHEON CO.**, Lexington, Mass., has reached an agreement in principle to purchase substantially all of the assets of **RHEEM SEMICONDUCTOR CORP.**, sub. of Rheem Mfg. Co., Mountain View, Calif.

**AMPEX CORP.**, Redwood City, Calif., has been awarded a contract of half million dollars by **BELL TELEPHONE LABORATORIES** for an undisclosed number of advanced video magnetic tape recorders to be used in the Army's NIKE-ZEUS anti-missile program.

**PACIFIC SEMICONDUCTORS, INC.**, Los Angeles, Calif., has announced plans to expand its size and activities with the integration of operations of PSI and **TRW COMPONENTS CO.**, consisting of the following divisions and subsidiaries of **THOMPSON RAMO WOOLDRIDGE INC.: RADIO INDUSTRIES, INC., RADIO CONDENSER CO., GOOD-ALL ELECTRIC MFG. CO., MILAM ELECTRIC MFG. CO.**, and the **MICROWAVE DIV.**

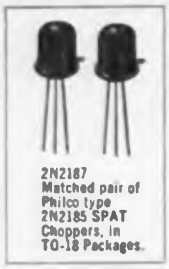
**SYLVANIA ELECTRIC PRODUCTS INC., ELECTRONIC DEFENSE LABORATORIES**, Mountain View, Calif., has begun work on a $314,700 contract for design and prototype production of electronic warfare equipment. The award was made by the U. S. Army Signal Research and Development Laboratories, Ft. Monmouth, N. J.

**EITEL-McCULLOUGH, INC.**, San Carlos, Calif., has received two orders totaling approximately $150,000 for amplifier klystrons. The tubes will be used to provide high-freq. power for Air Force tropospheric scatter communication systems.

A contract for "a study of interplanetary transportation systems" has been awarded to **LOCKHEED MISSILES & SPACE CO.** by NASA's Marshall Space Flight Center, Huntsville, Ala. The contract for some $65,000 calls for systematic analysis of interplanetary spacecraft orbits with regard to future mission possibilities.

**HUGHES AIRCRAFT CO.**, Culver City, Calif., has been awarded a $68,500 contract by NASA's Marshall Space Flight Center, Huntsville, Ala., for the development of a rubbery-like sealant for use with super cold liquid propellants.

**MINNEAPOLIS-HONEYWELL REGULATOR CO.**, has announced plans for expanding its Ordnance Div. facility in Duarte, Calif. Construction is under way on a 22,000 sq. ft. wing to one of the two buildings presently occupied by the company.



2N2187
Matched pair of Philco type 2N2185 SPAT Choppers, in TO-18 Packages.

# New PHILCO matched Silicon Choppers

# HELP A MISSILE "FLY" TWICE

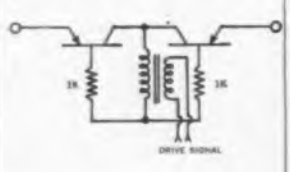
Philco SPAT* choppers, industry's most reliable telemetry multiplex switches, assure highest fidelity in multiplexing data from a missile's many sensors such as strain gauges and thermocouples—data that is the only legacy of a multi-million dollar missile flight. For this data is used in post-flight simulations which, in effect, make the missile "fly" twice.

Philco's missile-proved SPAT choppers are produced on industry's only fully-automatic chopper transistor production line—to assure the uniformity so important to matched pairs.

## Only Philco Choppers offer you these 6 advantages:

1. *Low Offset Current—1 nanoampere maximum;*
2. *Low Offset Voltage—50 μvolts maximum (for the matched pair);*
3. *Guaranteed Match over a temperature range—25° to 85° C;*
4. *Guaranteed maximum offset voltage for a wide range of base current values;*
5. *High gain-bandwidth product;*
6. *Meet all requirements of MIL-S-19500B.*

**TYPICAL CHOPPER CIRCUIT**




**2N2185 CHARACTERISTICS**

| | |
|---|---|
| Emitter Voltage, $BV_{ECO}$ | —30 volts |
| Collector Cutoff Current $I_{CBO}$ ($V_{CB}$ = —10V) | .001 μa max. |
| Emitter Cutoff Current $I_{EBO}$ ($V_{EB}$ = —10V) | .001 μa max. |
| Offset Voltage $V_{EE}$ ($I_B$ = —200 μa, $I_E$ = 0) | 1.5 mv max. |
| Offset Voltage $V_{EE}$ (2N2187 Matched pair, $I_B$ = —1 ma at all temperatures from 25°C to 85°C.) | 50 μv max. |

To assure maximum reliability in systems for telemetry, multichannel communications, analog computers, and other low level data handling applications, be sure to specify Philco SPAT choppers. There's a Philco SPAT chopper for every application. You can choose from seven types (2N2181 through 2N2187).

For complete data, write Department EI 1261.

Philco SPAT Choppers are immediately available from your Philco Industrial Semiconductor Distributor.

**PHILCO®**

*Famous for Quality the World Over*

LANSDALE DIVISION • LANSDALE, PENNSYLVANIA

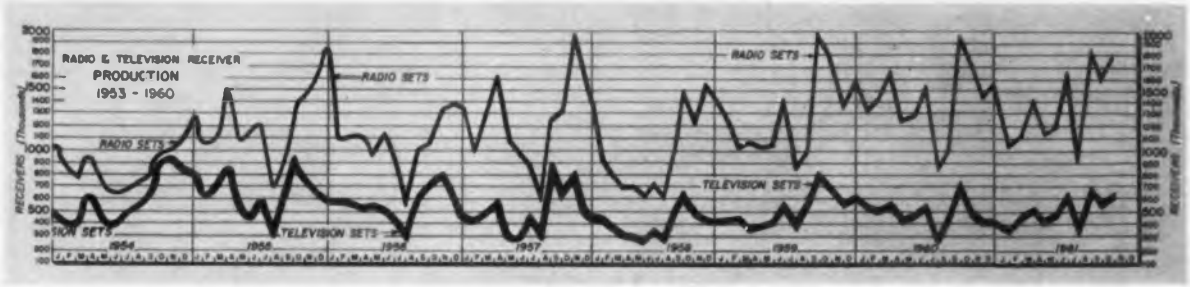
SOLID-STATE CENTER U.S.A.

*Philco Corporation Trademark for Silicon Precision Alloy Transistor

Circle 11 on Inquiry Card

*Facts and Figures Round-Up*
*December 1961*

# ELECTRONIC INDUSTRIES TOTALS




## GOVERNMENT ELECTRONIC CONTRACT AWARDS

*This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in October, 1961.*

| | |
|---|---|
| Accelerator | 323,532 |
| Amplifier | 2,002,216 |
| Analyzers | 30,669 |
| Antennas | 267,081 |
| Astro trackers | 1,821,807 |
| Automatic stabilization equipment | 355,000 |
| Batteries | 3,407,525 |
| Beta counting system | 82,700 |
| Cable Assys | 25,874 |
| Cable, RF | 59,056 |
| Cable, Telephone | 768,835 |
| Colorimeter | 75,913 |
| Capacitors | 25,129 |
| Coders/Decoders | 27,121 |
| Communications equipment | 136,242 |
| Communications systems | 2,980,000 |
| Comparator | 30,995 |
| Computer | 2,824,885 |
| Control Group | 70,406 |
| Data Link, Time Div. | 500,000 |
| Data processing equipment | 29,996 |
| Data recording instrument system | 26,487 |
| Delay lines | 142,464 |
| Drone surveillance system | 2,227,988 |
| Guidance system | 350,000 |
| Headset, microphone | 373,526 |
| Indicators | 2,732,324 |
| Inertial navigation system | 900,748 |
| Loudspeakers | 370,744 |
| Meters | 172,195 |
| Mobile radios | 48,038 |
| Modulators | 26,096 |
| Navigation equipment | 3,500,651 |
| Oscillators | 58,632 |
| Oscillographs | 62,952 |
| Oscilloscopes | 259,028 |
| Power supply | 177,198 |
| Radar | 8,957,800 |
| Radio set | 2,818,867 |
| Receiver | 1,426,511 |
| Receiving systems | 600,000 |
| Recorders | 289,165 |
| Recorder/Reproducer | 192,010 |
| Recording systems | 185,695 |
| Relay armature | 96,372 |
| Relay solenoid | 29,032 |
| Reproducer unit | 128,950 |
| Resistance standard | 37,401 |
| Resistors | 102,519 |
| Semiconductors | 148,944 |
| Signal generators | 95,534 |
| Sonar set | 8,837,294 |
| Switches | 283,488 |
| Synchro equipment | 179,779 |
| Telemetry equipment | 161,908 |
| Telephone equipment | 67,182 |
| Test set | 71,042 |
| Test equipment | 311,220 |
| Transceiver | 642,122 |
| Transformers | 99,722 |
| Transmitters | 620,267 |
| Tube, electron | 4,651,286 |
| Tube, klystron | 319,966 |
| Tuning drives | 230,160 |
| Waveguide assy | 50,600 |
| X-Ray equipment | 162,411 |

## Number and Median Salary of Scientists in the National Register, by Type of Employer and by Geographic Division, 1960

| Work activities | Geographic divisions | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | All divisions* | New England | Middle Atlantic | East North Central | West North Central | South Atlantic | East South Central | West South Central | Mountain | Pacific | Foreign |
| | Number | | | | | | | | | | |
| Research, development, or design | 42,126 | 3,150 | 10,379 | 7,023 | 2,270 | 6,335 | 1,335 | 2,810 | 1,991 | 6,519 | 299 |
| Management or administration: | | | | | | | | | | | |
| Total | 29,328 | 1,704 | 6,287 | 4,546 | 1,624 | 4,646 | 1,015 | 2,637 | 1,994 | 4,439 | 426 |
| Of R&D | 16,943 | 1,054 | 3,751 | 2,755 | 867 | 2,802 | 561 | 1,348 | 1,132 | 2,493 | 172 |
| Teaching | 16,885 | 1,427 | 2,995 | 3,511 | 1,711 | 1,943 | 699 | 1,322 | 970 | 2,222 | 118 |
| Production and inspection | 7,205 | 366 | 1,739 | 1,335 | 441 | 821 | 287 | 863 | 408 | 875 | 68 |
| Other activities | 13,835 | 619 | 2,527 | 1,801 | 877 | 1,735 | 422 | 2,051 | 1,220 | 2,138 | 439 |
| | Salary | | | | | | | | | | |
| Research, development, or design | $9,000 | $9,000 | $9,000 | $9,000 | $8,000 | $9,000 | $9,000 | $9,000 | $9,000 | $10,000 | $8,000 |
| Management or administration: | | | | | | | | | | | |
| Total | 12,000 | 12,000 | 13,000 | 12,000 | 11,000 | 11,000 | 10,000 | 12,000 | 9,000 | 11,000 | 12,000 |
| Of R&D | 12,000 | 13,000 | 14,000 | 12,000 | 11,000 | 12,000 | 11,000 | 13,000 | 10,000 | 12,000 | 12,000 |
| Teaching | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 7,000 | 7,000 | 7,000 | 7,000 | 8,000 | 7,000 |
| Production and inspection | 8,000 | 8,000 | 9,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 9,000 |
| Other activities | 8,000 | 8,000 | 9,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 | 9,000 |

* Total column includes 39 who gave no report of location.

Source: National Register of Scientific and Technical Personnel, 1960.


*Illustrations approximately ½ size*

# Sarkes Tarzian Tube Replacement Silicon Rectifiers improve circuit performance

These standard Tarzian tube replacement rectifiers are directly interchangeable with over 95% of all popular vacuum tube rectifiers. Although they are generally smaller and more compact than the tubes they replace, their dc current ratings are as much as three times as high.

In addition, they offer the inherent advantages of solid state rectification:

1. Greater electrical stability
2. Compact, rugged construction
3. Instant operation; no warmup; no filament supply
4. Cooler operation

For applications requiring high efficiency, wide temperature range, and long-period, maintenance-free operation, these compact units are unmatched. They are available in production quantities, at realistic prices. Special designs and modifications engineered on request. Special tube replacement units designed by Tarzian engineers include rectifiers with peak inverse voltages to 19,000.

Write for specifications and prices of tube replacement silicon rectifiers. Application engineering service is available on request.

*Quality in volume*

**SARKES TARZIAN, INC.**

World's Leading Manufacturers of TV and FM Tuners • Closed Circuit TV Systems • Broadcast Equipment • Air Trimmers • FM Radios • Magnetic Recording Tape • Semiconductor Devices

**SEMICONDUCTOR DIVISION • BLOOMINGTON, INDIANA**

*In Canada: 700 Weston Rd., Toronto 9 • Export: Ad Auriema, Inc., New York*

FROM THE **KEYSTONE** **THERMISTOR** DIVISION

a complete line of DISC TYPE units for RADIO and TELEVISION use

YOUR **ONE-STOP** SHOPPING CENTER

## service

Keystone provides the service you want when you need it—immediate application counsel—on-shelf stocking of these and many other standard thermistor types—prompt deliveries to keep your production lines rolling! Our service matches Keystone's product versatility—for both.

## quality

You're assured of high uniformity from unit to unit within each shipment from Keystone and close adherence to the specified nominal values within your tolerances. Quality silvering techniques and extreme care in affixing leads assure good appearance and physical strength. The result is lower inspection costs and fewer assembled rejects for you.

## price

Keystone thermistor prices are realistic, and competitive. Our automated production methods and high manufacturing volume permit the most practical pricing policies. Service has never been better, quality has never been higher, and our efficiency has never been greater. Check us now.

*Write, phone or wire for prompt quotations*

Keystone **CARBON COMPANY**
THERMISTOR DIVISION
ST. MARYS, PA.

**SILICON "RIBBONS"**

J. A. Gutowski (l), and E. S. Greiner of Bell Telephone Laboratories examine growth of "ribbons" (semi-transparent thin) of silicon in a quartz tube just removed from the furnace. The ribbons are near perfect crystals.

**ENVIRONMENTAL VAULT**

Goodyear Aircraft engineer Richard B. Holmes makes notes in reverberant tank which will later be used to bombard aircraft component with high-intensity sound to determine its vulnerability to space age conditions.

**"TAPE TANKS"**

Storage tanks at Minnesota Mining and Manufacturing Company's new Freehold, N. J., magnetic tape plant hold iron oxide dispersion which is fed to coating machines for application to plastic backing material.

# Snapshots . . . of the Electronic Industries

**"SCIENTIFIC CURIOSITY"**

Photo from Battelle Memorial Institute, Columbus, Ohio, shows a single indium phosphide crystal. The relatively new semiconductor is shown magnified about ten times. It is a scientific curiosity because of the presence of the cavity in its center and the equilaterally triangular shape of the cavity, which is about ⅛ in. deep.

**HEAT TREATMENT**

Miniature traveling wave tube, called the STX-186, is readied for brazing at the Great Neck, N. Y., facility of the Sperry Electronic Tube Division. Amplier (held between the two circular plates inside the r-f generator) can produce more than ten watts over frequency ranges from 5,000 to 11,000 MC for space communications.

**GREENLAND RADAR**

Dew East "DYE-1" site on Western shore of Greenland has detection radar equipment housed in the large radome and 120-foot high "billboard" antennas used for communication between sites. Western Electric was prime contractor to the USAF for engineering, installation and testing of the project's electronic and communication services.

**"AIR-CUSHION ROOM"**

Sound-proof chambers for testing of precision microphones at Shure Brothers, Inc., Evanston, Illinois, is entirely padded in sound-deadening, spun-glass wedges. Room is further isolated by an air-cushion that actually suspends the room independently.

**COMPLETELY TRANSISTORIZED**

Model Joan Franks says assembly of her new two-way radio kit is almost as easy as polishing her nails. Walkie-Talkie, developed by Electrosolids Corp., Sylmar, Calif., is completely transistorized with a range of ½ mi.

**RADAR FLEET**

Boston Tow Boat Co. tugs ATHENA, ORIAN, MARS, JUNO, TRITON and HERCULES have been equipped with Raytheon radars, becoming an all-weather fleet. Three at left have Model 1500 radars with 32-mile range while the others have Model 1700 radars with 12-mile range.

# Why FAIRCHILD SEMICONDUCTOR uses B&A electronic chemicals


A Fairchild Semiconductor technician mixes B&A chemicals for use in the transistor etching process. Etching is one of the important steps in the manufacture of silicon Planar transistors.

Ultra-high purity B&A® "Electronic Grade" Chemicals help improve production control, reduce rejects, and assure the highest reliability in Fairchild Semiconductor Silicon Planar transistors, diodes, Special Assemblies and Micrologic Elements.

Because of their sensitivity and reduced size, transistors and diodes are critically affected by impurities. The active areas of these products are on silicon "chips" the size of a not-too-sharp pencil point. Varying patterns on these "chips" are controlled by several etching and washing operations. In these delicate first phases, the purest of chemicals are required to assure reliability in the final product.

That's why Fairchild specifies B&A "Electronic Grade" chemicals. These electronic chemicals meet the strictest standards for purity and uniformity . . . hold impurities to the lowest levels ever attained.

If chemical purity affects the quality of *your* products, you ought to know the full story of B&A "Electronic Grade" quality. A request on your letterhead will bring detailed information.

**BAKER & ADAMSON®**
**"Electronic Grade" Chemicals**

Allied Chemical

**GENERAL CHEMICAL DIVISION**
40 Rector Street, New York 6, N. Y.

Please send export inquiries to: Allied Chemical International, 40 Rector Street, New York 6, N.Y.

# ANNOUNCING THE FAIRCHILD FD600

# PLANAR

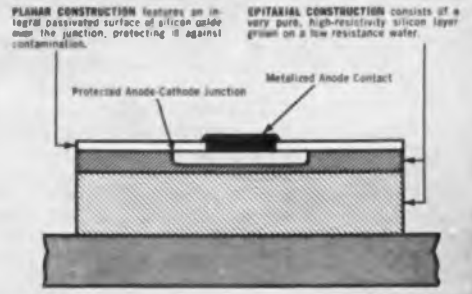
## for surface protection and reliability

# EPITAXIAL

## for high speed, high conductance

# DIODES

FAIRCHILD PLANAR EPITAXIAL DIODE STRUCTURE




### EPITAXIAL CONSTRUCTION

A thin pure silicon epitaxial layer provides high breakdown voltage, low capacitance and fast reverse recovery. Added mechanical strength, low resistance path to the collector connection are made possible by thicker, low resistivity supporting wafer.

### SILICON PLANAR RELIABILITY

An integral silicon oxide surface permanently protects the junction against contamination from the start of manufacture.

### ADVANTAGES

Increases current handling capabilities of diode matrices without reducing speed. Decreases number of gate amplifiers between diode gates in series diode logic circuitry.

### APPLICATIONS

High-speed, high conductance applications such as avalanche circuitry; core drivers; logarithmic amplifiers for pulse applications; critical circuitry requiring high conductance and low internal power dissipation, without sacrificing speed.

### FD600 GUARANTEED CHARACTERISTICS

| | |
|---|---|
| Forward Current | 200 mA (min.) @ 1 Volt |
| Breakdown Voltage | 75 Volts (min.) @ 5 μA |
| Capacitance | 2 μμf (max.) @ 0 Volts |
| Reverse Current | 50 mμA (max.) @ 50 Volts |
| Power Dissipation | 500 mW @ 25° C |

### REVERSE RECOVERY TIME SPECIFIED FOR YOUR USE

● For magnetic memory applications

Fast recovery with no turn-off current required

$t_{rr}$=20 mμ sec ($I_F$ = 200 mA, $I_R$ = 0 mA)

● For current mode switching in driver applications

Fast recovery with high forward conductance

$t_{rr}$=2 mμ sec ($I_F$=$I_R$=10 to 400 mA)

● For diode logic applications

Fast recovery with low reverse current

$t_{rr}$=4 mμ sec ($I_F$=10 mA, $I_R$=1 mA, recovery to 0.1 mA)

FAIRCHILD

SEMICONDUCTOR

545 WHISMAN ROAD, MOUNTAIN VIEW, CALIF. · YORKSHIRE 8-8161 · TWX: MN VW CAL 853

A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

# EI's International News

## AFRICA

### New Broadcasting Station in Ghana

President Nkrumah of Ghana recently pressed a button which inaugurated the most modern broadcasting system on the African Continent. The station has four 100 kw transmitters capable of world coverage.

The entire project was the responsibility of Marconi's Wireless Telegraph Co., Ltd. The contract was awarded by the Ghana Government. The station, which is at Tema, near Accra, is built in the form of a hollow square, with a spacious rectangular courtyard occupying the enclosed area. The buildings have been specially designed to cope with earthquake shocks and the effects of solar heat and salt-laden air. A microwave radio link connects the studios at Accra with the transmitters at Tema.

## AUSTRALIA

### Powerful Transmitter For Navy's Network

Continental Electronics Mfg. Co. of Dallas, subsidiary of Ling-Temco-Vought, Inc., is to design a super-power VLF radio communications transmitter for fleet communications in the Pacific.

To be located in Australia, the transmitter will be similar to the Navy's most powerful radio station, a 2-million-watt facility in Cutler, Me., for which Continental was prime contractor. The new installation in Australia is capable of communicating with all vessels, including submerged Polaris submarines.

Known as "VLF Pacific," it will augment the Navy's world-wide radio network.

## CANADA

### Representatives Appointed

Industrial Electronic Engineers, Inc., announced that Whittaker Electronics Ltd., electronic manufacturers representatives of Ottawa, Ontario have been appointed to represent the company in Central and Eastern Canada. Whittaker Electronics will carry the complete line of IEE products.

## ENGLAND

### French Select British Aircraft Landing System

French aviation authorities have selected the Pye Instrument Landing System, incorporating a directional localizer, for installation at their research and development center at Bretigny, near Paris, where work on military and civil aircraft landing systems is carried out.

Pye Telecommunications Ltd. of Cambridge, England, have now supplied over 135 Instrument Landing Systems which are in use throughout the world.

### UNDERCOVER WORK

European engineers of the International Telephone and Telegraph Corporation work on installation of a buried transistor repeater for a carrier telephone system in Sardinia using a new type of coaxial cable that is thinner than a pencil.

### RCA and British Firm Sign Computer Agreement

Two multi-million dollar agreements, one for the sale of electronic data processing systems and the other for the exchange of patent licenses for the same equipment, have been signed by the Radio Corp. of America and International Computers and Tabulators Limited of England.

I.C.T. has placed an initial order for the purchase of 50 RCA data processing systems. The agreement provides an option for the English firm to purchase 50 or more additional systems. Shipments will begin in quantity by mid-1962 and be completed by 1964. The data processing systems can be marketed in the United Kingdom as well as in all other areas of the world. Under the patent license agreement, RCA has granted I.C.T. non-exclusive patent licenses for the manufacture and sale of data processing equipment. At the same time, I.C.T. has granted RCA non-exclusive patent licenses for the manufacture and sale of data processing equipment.

I.C.T. also will have at its disposal technical information relating to the manufacture of data processing equipment produced by RCA. Included will be information on related services, such as: programming, testing, installation, training, and service and maintenance. RCA will be entitled to similar technical information from the British firm.

### Raytheon Plans Expansion For British Subsidiary

Raytheon's new British subsidiary A. C. Cossor, Ltd., will be expanded and its marketing potential strengthened, Charles F. Adams, Raytheon board chairman said as he outlined his company's plans following a directors' meeting of the British electronics firm.

Raytheon acquired Cossor by purchasing the ordinary shares and the preference shares at a total price of about $6,000,000. The firm employs approximately 2,600 persons.

During the next few months a careful analysis will be made of Cossor's products and markets in order to take the fullest advantage of complementary Raytheon products that can be offered through the existing channels of distribution. Cossor products will also be reviewed for export through Raytheon distribution channels.

## FORMOSA

### Formosa to Okinawa Link

The Formosa to Okinawa communications system is one of the world's longest operational tropospheric scatter systems, covering a distance of 409 miles. This Forward Propagation Tropospheric Scatter is managed by the U. S. Army's Signal Engineering Agency.

The system connects the Sukiran Communications Center on Okinawa with the Military Aid and Assistance Group's Communication Center on Taiwan (Formosa).

Playing a key role in the system are four antennas, specially designed and fabricated by Blaw-Knox Company, Pittsburgh, for Alpha Corporation, Richardson, Texas. Alpha is a division of Collins Radio Company.

The tropospheric scatter communication antennas are similar in design to B-K units in use on the DEW (Distant Early Warning) Line and BMEWS (Ballistic Missile Early Warning System).

The two scatterers at Okinawa are on Yaetake Mountain — 1,200 feet above sea level; while the two antennas at the Formosan site, on Seven Star Mountain, are at an elevation of 3,000 feet with a clear horizon to the ocean toward Okinawa.

Alpha engineers designed the system with a high degree of redundancy to insure high reliability of equipment and propagation.

More International News On Page 34



You can place the utmost confidence in Dale precision resistors even when today's new and unprecedented standards of "missile reliability" are the goals towards which you are designing.

Under any and all conditions, Dale resistors retain their stability because it has been "firmly infixed" by Dale design and methods of manufacture . . . methods which have now reached new levels of achievement as part of Dale's super-high reliability development program.

*SPECIAL PROBLEMS?* Let us help you with your requirements for special resistance products. We make modifications of standard products, resistor networks, matched pairs, etc. Send us your specs.

*PROMPT DELIVERY.* Whether your need is for a short "test run" or a large production release, Dale offers prompt service, direct from the factory and through a widespread network of distributors.

*Write for Bulletins R-23, R-25 and R-30*

Hathaway INSTRUMENTS INC.

**DALE ELECTRONICS, INC.**

1304 28th Ave., Columbus, Nebraska

*A subsidiary of* **HATHAWAY INSTRUMENTS, INC.**

**DALE TYPE RS RESISTORS**

**WIRE WOUND • PRECISION • POWER**

Designed for advanced electronic circuits where space is at a premium. Three configurations: Type RS with axial leads and in most ratings and resistances shown; Type RLS with radial leads; Type RSE for clip mounting.

- Rated at ½, 1, 2, 2½, 3, 5, 7, 10 watts
- Resistance range from .05 ohm to 175K ohms, depending on type
- Tolerance 0.05%, 0.1%, 0.25%, 0.5%, 1%, 3%
- Temperature coefficient within 0.00002/ degree C.
- Operating temperature range from —55° C. to 275° C.
- Smallest in size, ranging from 5/64" by 5/16" to 3/8" by 1-25/32". Ten choices
- Completely protected, impervious to moisture and salt spray
- Complete welded construction from terminal to terminal
- Silicone sealed, offering high dielectric strength and maximum resistance to abrasion
- Meet functional requirements of MIL-R-26C



Circle 98 on Inquiry Card

# FILMISTOR®

# METAL FILM RESISTORS OFFER 5 DISTINCT TEMPERATURE COEFFICIENTS TO MEET ALL CIRCUIT REQUIREMENTS

**RUGGED END-CAP CONSTRUCTION FOR LONG TERM STABILITY**

• • •

**EXCEPTIONAL RESISTANCE TO MOISTURE AND MECHANICAL DAMAGE**

• • •

**SURPASS MIL-R-10509 PERFORMANCE REQUIREMENTS**

Providing close accuracy, reliability and stability with low controlled temperature coefficients, these molded case metal-film resistors outperform precision wirewound and carbon film resistors. Prime characteristics include minimum inherent noise level, negligible voltage coefficient of resistance and excellent long-time stability under rated load as well as under severe conditions of humidity.

Close tracking of resistance values of 2 or more resistors over a wide temperature range is another key performance characteristic of molded-case Filmistor Metal Film Resistors. This is especially important where they are used to make highly accurate ratio dividers.

Filmistor Metal Film Resistors are automatically spiralled to desired resistance values by exclusive Sprague equipment. The metallic resistive film, deposited by high vacuum evaporation, bonds firmly to special ceramic cores. Noble metal terminals insure low-contact resistance.

The resistance elements, complete with end caps and leads attached are molded in dense, high temperature thermosetting material to form a tough molded shell for maximum protection against mechanical damage, moisture penetration and repeated temperature cycling.

Filmistor Metal Film Resistors, in ⅛, ¼, ½ and 1 watt ratings, surpass stringent performance requirements of MIL-R-10509D, Characteristic C and E. Write for Engineering Bulletin No. 7025 to: Technical Literature Section, Sprague Electric Co., 233 Marshall Street, North Adams, Mass.

*For application engineering assistance write: Resistor Division, Sprague Electric Co. Nashua, New Hampshire*

**SPRAGUE COMPONENTS**

| | | |
|---|---|---|
| RESISTORS | INTERFERENCE FILTERS | HIGH TEMPERATURE MAGNET WIRE |
| CAPACITORS | PULSE TRANSFORMERS | CERAMIC-BASE PRINTED NETWORKS |
| MAGNETIC COMPONENTS | PIEZOELECTRIC CERAMICS | PACKAGED COMPONENT ASSEMBLIES |
| TRANSISTORS | PULSE-FORMING NETWORKS | FUNCTIONAL DIGITAL CIRCUITS |

**SPRAGUE**
*THE MARK OF RELIABILITY*

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

ANOTHER FINE PRODUCT OF FAIRCHILD RESEARCH

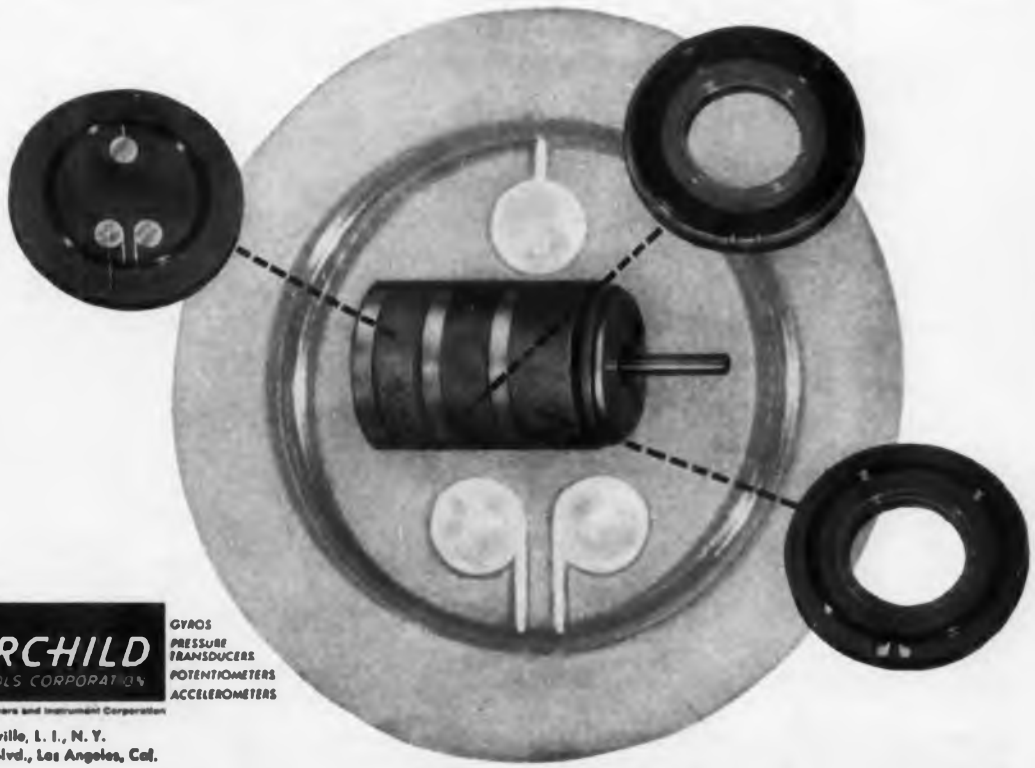
# "FAIRITE" CONDUCTIVE PLASTIC POTENTIOMETERS

Fairchild, the leader in precision potentiometers, takes another giant stride in technological progress with infinite-resolution, conductive plastic potentiometers having Fairchild reliability "built-in" ■ "Fairite" potentiometers utilize a continuous track of specially prepared, conductive, high impact plastic co-molded with an insulating base of the same heat-resistant material to provide superior performance under temperature and humidity extremes ■ Temperature cycling tests of this advanced Fairchild design shows that resistance values are consistently reproduced ■ Resistance stability is maintained by Fairchild's unexcelled production skills which assure sufficient conductor bulk to virtually eliminate effects of wear ■ Low end-loss positive connections are achieved through co-molding of silver terminations with the conductive track. In addition, track geometry can be varied to obtain optimum functional conformity ■ Reliable operating life of many millions of cycles is assured through the resistance stability of Fairchild's "Fairite" conductive plastic potentiometers. For more information, write Dept. 53-EI.

**FEATURES:** INFINITE RESOLUTION/UNSURPASSED RELIABILITY/RESISTANCE STABILITY/CONSTANT RESISTANCE VALUES/LOW END-LOSS/LONG LIFE/COMPLETE RANGE OF SIZES

| ELECTRICAL | |
|---|---|
| Resistance Range, ohms | 2K — 50K ± 10% |
| Ind. Linearity | 0.5% standard |
| Resolution | Virtually infinite (less than .005") |
| Temperature Coefficient | Negative 3-400 ppm |
| Power Rating | 2 watts at 20°C |

| ENVIRONMENTAL | |
|---|---|
| Temperature Range | —65°C to + 150°C |
| Humidity | 95% to 100% RH at 71°C |
| Vibration | 10G's to 2000 cps |
| Life | Over 10 million cycles at 600 rpm |



FAIRCHILD CONTROLS CORPORATION
A Subsidiary of Fairchild Camera and Instrument Corporation

GYROS
PRESSURE TRANSDUCERS
POTENTIOMETERS
ACCELEROMETERS

225 Park Ave., Hicksville, L. I., N. Y.
6111 E. Washington Blvd., Los Angeles, Cal.

# International News

(*Continued from page* 30)

## *GERMANY*

### International Award

A polystyrene transistor radio and record player designed by the Max Braun Co. of Frankfurt, Germany, was given "The Supreme Award For the Best Designed Plastics Consumer Product" in the International Design Display at the International Plastics Exhibition in London, England. All transistorized, portable radios and table-model AM/FM radio-stereo record players manufactured by the Max Braun Co. are distributed in North America by the Clairtone Sound Corp., Ltd. of Toronto, Canada, under the combined logo Clairton-Braun.

### West German Electron Tubes to be Sold in U. S.

A complete line of electron tubes manufactured in West Germany will be marketed in the U. S. by United Electronics Co., Newark, N. J. Dr. John R. Beers, United president, has announced a marketing agreement with Siemens & Halske, one of the world's leading producers of electron tubes.

Siemens & Halske has developed and now manufactures several hundred models of electron tubes. Many of these tubes will be distributed by United Electronics in three broad categories: Special amplifier tubes, having a 10,000-hour guarantee, for instrument, industrial and professional application; Transmitting and generating tubes used in communications and industrial RF applications; Microwave tubes, including Klystrons, traveling wave tubes, backward wave oscillators, and planar triodes.

### "World Microwaves"

This report, listing the potential microwave markets around the world, appeared in the International News Section of our November 1961 issue.

The information was inadvertently credited to the U. S. Chamber of Commerce. It was actually provided by the Electronics Division, Business and Defense Services Administration, U.S. Dept. of Commerce.

Additional information on microwave developments has been collected since that original report and is now available as is added detail within the department.

Also, the Communications Industries Division of BDSA has a new series of reports on the Market for U.S. Telecommunications equipment in Argentina, Haiti, Jamaica, Surinam, Trinidad and Tobago, Peru, Uruguay and Venezuela.

Copies of both the microwave and telecommunications reports can be obtained from Sales and Distribution, U.S. Dept. of Commerce, Washington 25. D.C. at ten cents a copy.

# NEW DEVELOPMENT
# BENDIX®
# 3-AMP DAP


Designers can count on the new Bendix 3-amp DAP® power transistor series for greater efficiency in switching and audio applications. These diffused-base units offer low input resistance, outstanding gain characteristics, and high collector-to-emitter voltages. And every unit is "Dynamically Tested", an exclusive Bendix quality control process that assures uniform reliability. Dimensions conform to JEDEC TO-37 outline with collector electrically connected to case. Write to Holmdel, N. J., for details.

**MAIN OFFICE:** Holmdel, N.J.—Ph: SH 7-5400 • **NEW ENGLAND OFFICE:** 114 Waltham St., Lexington, Mass.—Ph: VO 2-7650 • **DETROIT OFFICE:** 12950 West 8 Mile Rd., Detroit 37, Mich.—Ph: JO 6-1420 • **MIDWEST OFFICE:** 2N565 York Rd., Elmhurst, Ill.—Ph: BW 9-5050 • **WEST COAST OFFICE:** 117 E. Providencia Ave., Burbank, California—Ph: VI 9-3961 • **CANADIAN AFFILIATE:** Computing Devices of Canada, P.O. Box 508, Ottawa 4, Ont. • **EXPORT OFFICE:** Bendix International, 205 E. 42nd Street, New York 17, N.Y. • **STOCKING DISTRIBUTOR:** Contact nearest sales office for local distributor.

| Absolute Maximum Ratings: | $V_{CE}$ Vdc | $V_{CEO}$ Vdc | $V_{CB}$ Vdc | $I_C$ Adc | $P_C$* W | $T_{stg}$ °C | $T_J$ °C |
|---|---|---|---|---|---|---|---|
| B-1013 | 60 | 30 | 60 | 3 | 5 | −65 to +110 | 110 |
| B-1013A | 100 | 60 | 100 | 3 | 5 | −65 to +110 | 110 |
| B-1013B | 200 | 100 | 200 | 3 | 5 | −65 to +110 | 110 |

*$P_C$ is the maximum average power dissipation. It can be exceeded during the switching time.



ACTUAL SIZE

**Bendix Semiconductor Division**

THE Bendix CORPORATION



Circle 19 on Inquiry Card

## Can high-power coaxial cable be really flexible?

Yes, if it's our new perforated Teflon® tape cable—type RG-281/U. Here's an extra-flexible, high-power coaxial cable originally developed for an Air Force electronic counter measures system.

Besides its flexibility, it offers many other advantages:

☐ *Greater Thermal Stability* of this unique dielectric construction eliminates voids between cable and connector dielectrics; thus moisture condensation at dielectric interface is minimized.

☐ *True Dimensional Concentricity,* impossible with semi-solid dielectrics employing filament construction, is achieved by perforated Teflon tape. Concentricity, even over small bending radii, is maintained because center conductor is continuously supported by dielectric. There are no filaments to slip and bunch under flexing.

☐ *VSWR less than 1.2.* The perforated Teflon tape gives a *uniform distribution* of air spaces in the dielectric.

☐ *Low Loss*—A dielectric constant of 1.55, compared to 2.0 for solid Teflon, assures improved power transmission.

Use Amphenol brand RG-281/U as a general purpose radio-frequency transmission line in applications involving high power, low loss, flexibility, high temperature, dimensional stability and exacting electrical characteristics.

Write today for Data Sheet to: FXR, 33 East Franklin Street, Danbury, Connecticut. ®Du Pont

FXR THE RF PRODUCTS AND MICROWAVE DIVISION AMPHENOL-BORG ELECTRONICS CORPORATION

Circle 20 on Inquiry Card

# 90% *lower* $t_s$ *... 25 nsec max.*

# 70% *lower* $V_{CE}(sat)$ *... 0.45 V max.*

# 50% *lower* $C_{ob}$ *... 18 μμf max.*

*... with new Sylvania...* **SILICON**

# epitaxial mesas

## • 2N1958 • 2N1959 *(compared with conventional mesa types 2N696, 2N697)*

**Sylvania 2N1958 and 2N1959 . . . first 2-watt transistors to handle 500 mA of collector current in a total switching time of 110 nsec.**

Exclusively epitaxial! Now *ALL* Sylvania Silicon Mesa transistors are produced by the epitaxial process. Exceptional Sylvania knowledge of solid state physics combined with extraordinarily automated processing and testing techniques continue to advance the state of the art. The new Sylvania 2N1958 and 2N1959—improved 2N696 and 2N697 conventional Silicon Mesa types—are dynamic evidence of the benefits offered design engineers by (1) epitaxial techniques and (2) transistors quantity-produced by Sylvania for switching and amplifier circuitry operating in the nsec range.

Sylvania 2N1958 and 2N1959 Epitaxial Silicon Mesa transistors are now available from your Sylvania Franchised Semiconductor Distributor and your Sylvania Sales Engineer. For tech data write to Semiconductor Division, Sylvania Electric Products Inc., Dept. 185, 1100 Main Street, Buffalo 9, New York.

**Absolute Maximum Ratings of 2N1958 and 2N1959 at 25°C**

| | |
|---|---|
| Storage Temperature, $T_{stg}$ | −65°C to +300°C |
| Junction Temperature, $T_j$ | +175°C |
| Collector to Base Voltage, $V_{CB}$ | 60 Volts |
| Emitter to Base Voltage, $V_{EB}$ | 5 Volts |
| Collector-Emitter Voltage, $V_{CER}$ | 40 Volts |
| Collector Current, $I_C$ | 500 mA |
| Total Power Diss., (free air), $P_T$ | 800 mW |
| Total Power Diss., (case at 25°C), $P_T$ | 2 Watts |

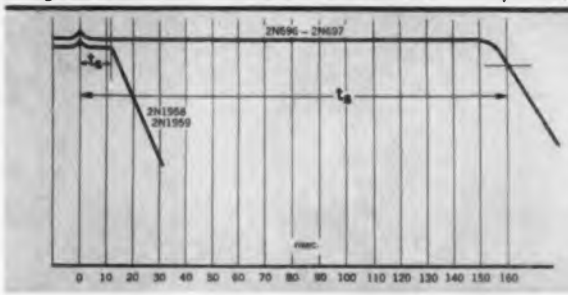
Sylvania 2N1958, 2N1959—
TO-5 Package—½ Actual Size

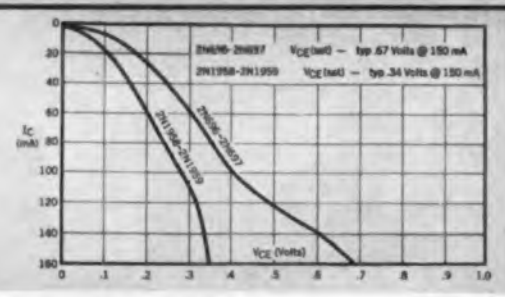
**Electrical Characteristics at 25°C:**

| | 2N1958 Min. | 2N1958 Max. | 2N1959 Min. | 2N1959 Max. | Unit |
|---|---|---|---|---|---|
| $BV_{CBO}$ ($I_C$ = 100 μA, $I_E$ = 0) | 60 | — | 60 | — | Volts |
| $BV_{EBO}$ ($I_E$ = 100 μA, $I_C$ = 0) | 5 | — | 5 | — | Volts |
| $BV_{CER}$ ($I_C$ = 30 mA, $I_B$ = 0, $R_{BE}$ = 10 Ω) | 40 | — | 40 | — | Volts |
| $I_{CBO}$ ($V_{CB}$ = 30 V, | — | 500 | — | 500 | mμA |
| $V_{CB}$ = 30 V, T = 150°C) | — | 300 | — | 300 | μA |
| $H_{FE}$ ($I_C$ = 150 mA, $V_{CE}$ = 10 V) | 20 | 60 | 40 | 120 | — |
| $V_{BE}$ ($I_C$ = 150 mA, $I_B$ = 15 mA) | — | 1.3 | — | 1.3 | Volts |
| $V_{CE}$ (sat) ($I_C$ = 150 mA, $I_B$ = 15 mA) | — | 0.45 | — | 0.45 | Volts |
| $h_{fe}$ ($V_{CB}$ = 10 V, $I_C$ = 25 mA, F = 100 MC) | 1 | — | 1 | — | — |
| $C_{ob}$ ($V_{CB}$ = 10 V, $I_E$ = 0, F = 1 MC) | — | 18 | — | 18 | μμf |
| $t_{on}$* ($I_{B1}$ = 15 mA, $I_{B2}$ = 15 mA, $I_C$ = 150 mA, $V_{CC}$ = 7 V, $R_L$ = 40 Ω) | — | 65 | — | 65 | nsec |
| $t_d$* ($I_{B1}$ = 15 mA, $I_{B2}$ = 15 mA $I_C$ = 150 mA, $V_{CC}$ = 7 V, $R_L$ = 40 Ω) | — | 25 | — | 25 | nsec |
| $t_{off}$* ($I_{B1}$ = 15 mA $I_{B2}$ = 15 mA, $I_C$ = 150 mA, $V_{CC}$ = 7 V, $R_L$ = 40 Ω) | — | 85 | — | 45 | nsec |

*$t_{on}$, $t_d$, and $t_s$ measured from 50% point of input pulse

Curves compare storage time ($t_s$) and saturation voltage $V_{CE}$ (sat) of 2N696, 2N697 and Sylvania-originated 2N1958 and 2N1959. Note significant improvements offered by Sylvania epitaxial mesas 2N1958, 2N1959.




# SYLVANIA

SUBSIDIARY OF

## GENERAL TELEPHONE & ELECTRONICS

GENERAL TELEPHONE SYSTEM

# MEASURE AC VOLTAGE to 500 KC WITH YOUR DC VOLTMETER

# NEW hp 457A AC TO DC CONVERTER

New hp 457A AC to DC Converter lets you inexpensively measure ac voltage, 50 cps to 500 KC, with the ease and high resolution of a dc digital voltmeter.

The average-responding 457A permits ac measurements to ±0.3% of reading ±0.001 v to 50 KC and ±0.75% ±0.001 v to 500 KC. This accuracy permits you to read ac voltages on a dc digital voltmeter (such as the hp 405BR/CR) with three digits resolution.

Waveform errors are minimized by this new converter. The dc output of the 457A is always between 0 and 1 volt for up to full scale input. Full scale is selected manually in decade ranges. Your measurement convenience is further increased with overranging by more than 2 to 1 and an input impedance of 1 megohm.

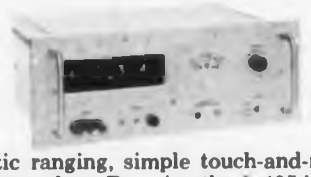
The 457A Converter can be used with an hp 560 Series Digital Recorder, plus a digital voltmeter, to provide a permanent printed record. Either the 457A analog or digital voltmeter output data is suitable for other data logging equipment. The digital data may be transferred, for example, to card or tape punches.

New hp instrument modular packaging permits easy stacking of instruments on the bench and simple conversion to rack mount.

## Specifications

| | |
|---|---|
| **Input Range:** | 0 to 300 v rms, in 4 decade ranges corresponding to 1, 10, 100 and 1,000 v rms full scale. |
| **Frequency Range:** | 50 cps to 500 KC |
| **Accuracy:** | ±0.3% of reading ±1 mv, 50 cps to 50 KC; ±0.75% ±1 mv, 50 KC to 500 KC. |
| **Output:** | 0 to 1.0 v dc, responding to average value of ac input, with output calibrated as rms value of sine wave. |
| **Output Impedance:** | 10,000 ohms. |
| **Input Impedance:** | 1 megohm, shunted by 30 pf. |
| **Size:** | 16¾" wide, 3⅜" high, 13¼" deep. Weight, 12 lbs. |
| **Price:** | $350.00 |

# hp DEPENDABLE AUTOMATIC DIGITAL VOLTMETERS



## hp 405BR/CR Digital Voltmeter

Ideal for use with the hp 457A AC to DC Converter, the hp 405BR/CR Digital Voltmeters feature automatic ranging, simple touch-and-read measurement and bright, clear readout. By using the hp 405 in conjunction with the hp 457A, you can read ac voltages on the 405 to three digits with an overall accuracy of ±0.4% of reading ±0.001 v to 50 KC, ±0.75% of reading ±0.002 v to 500 KC. The hp 405BR and CR are identical except that the 405CR includes (a) provision for external sampling command, (b) digital recording outputs, plus (c) reading hold-off capability, (d) print command when overranging, and (e) remote readout outputs.

## Specifications

| | |
|---|---|
| **Ranges:** | 0.001 to 999 v dc, 4 ranges. |
| **Presentation:** | 3 significant figures, polarity indicator. |
| **Accuracy:** | ±0.2% of reading ±1 count. |
| **Ranging Time:** | 0.2 sec to 2 sec. |
| **Input Impedance:** | 11 megohms to dc, all ranges. |
| **Response Time:** | Less than 1 sec. |
| **AC Rejection:** | 3 db at 0.7 cps; min. 44 db at 60 cps. |
| **Size:** | 7" high, 19" wide, 13⅞" deep behind panel. Weight, 26 lbs. |
| **Price:** | hp 405BR, $850.00; hp 405CR, $925.00. |

# FOR EVEN GREATER SYSTEMS FLEXIBILITY, USE DYMEC 2401 INTEGRATING DIGITAL VOLTMETER!

## DY-2401 Integrating Digital Voltmeter

Unique flexibility for simple and complex systems applications is yours with the Dymec 2401 Integrating Digital Voltmeter, which effectively eliminates the effects of noise and hum by reading the average value of voltage applied over a definite, selected sample period. Range, sample period and sample rate are externally programmable. Applications are further extended by the nature of the 2401, actually a voltage-to-frequency converter, combined with a 300 KC electronic counter.

Equally versatile in systems application is the Dymec Model 2410 Multi-Converter (not shown), which converts ac volts, resistance and dc volts to a proportional dc voltage with 1 volt nominal full-scale output. $1,975.00.

## Specifications

| | |
|---|---|
| **DC Voltage Ranges:** | ±0.1, 1, 10, 100, 1,000 v nominal full scale. |
| **Overall Accuracy:** | 0.05% nominal. |
| **Stability:** | Greater than 0.01%/day, 1 v range and above. |
| **Input Impedance:** | 1 megohm on 1 v and higher ranges, 100,000 ohms on 0.1 v range. |
| **Price:** | $3,750.00. |

**Call your Hewlett-Packard/Dymec representative today for further information or for a demonstration on your bench.**

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

**HEWLETT-PACKARD COMPANY**
1091B Page Mill Road Palo Alto, California, U.S.A.
Cable "HEWPACK" DAvenport 6-7000
*Field representatives in all principal areas*

**HEWLETT-PACKARD S. A.**
Rue du Vieux Billard No. 1 Geneva, Switzerland
Cable "HEWPACKSA" Tel. No. (022) 26. 43. 36

7273

# Tele-Tips

**THE FCC** is receiving its usual quota of odd-ball calls:

**NEWSPAPERS** reported "mysterious" actions of a radio-controlled garage door of a home near a Colorado plant which conducts test firings of missiles. There was implication that if a radio signal could open and close garage doors it might also trigger a missile. An FCC inquiry indicated that the erratic performance of the garage door was due to malfunctioning of the apparatus. However, missiles could not be set off by such remote-control devices because missile firing requires a complex coded signal which can not be reproduced by a simple radio transmitter.

**DISTURBANCE** to Denver police radio operations was pinned on a local radio-controlled garage door opener. Measurements showed that the radiation was 10 times the maximum permitted. Further inquiry indicated that adjustments made in a recent servicing job had shifted the radiation on to a police frequency. The owner immediately replaced his eight-year-old contrivance with a newer model.

**FCC MONITORING** intercepted programs from a station identifying itself as "WHTR, Home Town Radio," in a New York state community. There is no such authorized station, so Commission engineers traced the broadcasts to a backyard shack. They were greeted by a youth who escorted them inside where he "shushed" the visitors until a 16-year-old disk jockey completed playing a record. The operators were then informed that their station was illegal and it closed down with an on-the-air announcement to that effect. The next day the local newspaper summed up the situation with a headline, "RADIO STATION WHTR MAKES DEBUT, EXIT."

**A 15-YEAR-OLD** in St. Louis built a transmitter-less broadcast station for a school science fair. Later he tried it out with a transmitter. It covered a radius of 20

(*Continued on Page* 44)

# Specify MOTOROLA SILICON SEMICONDUCTORS

## *for the most performance per dollar!*

SILICON ZENER AND REFERENCE DIODES

SILICON RECTIFIERS

SILICON EPITAXIAL PLANAR TRANSISTORS

SILICON EPITAXIAL MESA TRANSISTORS

In mass production processes, in optimized device design, and in mastery of new epitaxial techniques, Motorola's advanced silicon semiconductor technology has made possible high performance, low-cost silicon devices for the designer.

Whether you need silicon rectifiers by the millions for high-volume, low-cost applications or high-gain, high-speed silicon mesa transistors for special circuit requirements, you get top performance value per dollar from Motorola.

And, this superior capability in silicon processing has brought you these firsts in silicon semiconductors from Motorola:

**1st** FIRST with 50 watt zeners . . . Motorola now offers over 2000 zener and reference diode types — the industry's most comprehensive line of silicon zener diodes.

**1st** FIRST to develop and mass produce by the millions the rugged, 18-amp, silicon rectifier for automotive alternators . . . Motorola now offers over 80 different types of silicon rectifiers for all segments of industry.

**1st** FIRST with the new "star" geometry in surface-passivated, silicon, epitaxial, planar transistors . . . Motorola now offers 9 devices in this new series.

**1st** FIRST volume producer of silicon-epitaxial mesa transistors . . . Motorola now offers over 10 different types for amplifier and switching applications.

FOR COMPLETE INFORMATION on silicon semiconductors, contact your local Motorola Semiconductor Distributor or District Office.

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POWER TRANSISTORS • MESA SWITCHING & AMPLIFIER TRANSISTORS • MILLIWATT TRANSISTORS • SILICON RECTIFIERS • ZENER DIODES

# HIGH-SPEED SWITCHING

# Check these CLARE Mercury-Wetted Relays against your design needs

## Choice of two basic switches

**SPEED TO 200 CPS**

This CLARE TYPE HGS is the fastest operating, most sensitive mercury-wetted contact relay obtainable. It will operate at speeds to 200 cps with sensitivity as low as 2.5 milliwatts with a contact rating of 2 amperes, 500 volts (100va max.). Two permanent magnets provide single-side stable and bi-stable adjustments. Available with Form D (bridging) contacts.

**LOADS TO 250 VA**

This CLARE HG capsule will handle contact loads as high as 5 amperes, 500 volts (250va max.). Operating time may be as low as 3 milliseconds. It is also available equipped with two permanent magnets (HGP TYPE) for single-side stable, bi-stable or chopper operation.

## The Clare Mercury-Wetted Relay Principle

The remarkably long life of CLARE mercury-wetted relays is the result of a design principle whereby a film of mercury on the contacts is constantly renewed, by capillary action, from a mercury pool. Both CLARE HGS and HG switch capsules employ this principle. Both switches are sealed in high-pressure hydrogen atmosphere. Certain construction differences, however, give greater speed and sensitivity to the HGS switch

# FOR BILLIONS OF OPERATIONS

## Choice of three convenient packages

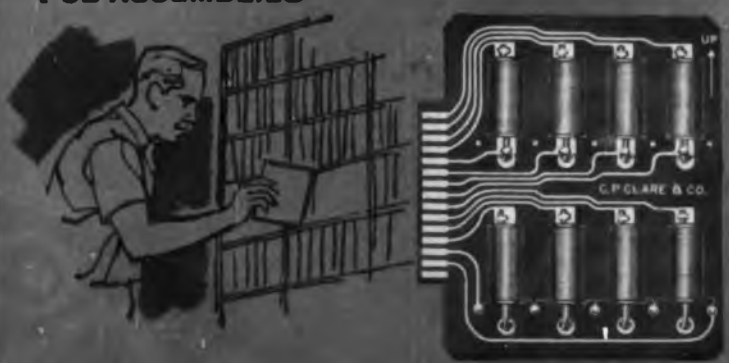
**ENCLOSED MODULES**

Both CLARE HGS and HG switch capsules are available in steel-enclosed modules for convenient mounting on printed circuit boards in the same manner as resistors, capacitors and similar components. The enclosure is ruggedly designed and provides both excellent mechanical protection and magnetic shielding. These modules are ideal for design and prototype work.

**CONVENTIONAL PLUG-IN RELAYS**

CLARE HGS switch capsules are available in single switch units, surrounded by a coil, mounted in high-melting point wax and encased in cylindrical steel containers provided with plug-in base. A smaller type (HGSS) is designed for use where space is limited. HG relays are available with one, two, three, or four capsules, surrounded by a single coil. Also with permanent magnets (HGP) for single-side stable, bi-stable or chopper operation.

**PCB ASSEMBLIES**




Printed circuit board assemblies are available with either HGS or HG switch capsules to meet design specifications. These may be designed to customer specifications by CLARE or mounted on boards supplied by the customer. Number of relays is limited only by the dimensions of the printed circuit board.

**NEW! Design Manual 201A**

Complete data on characteristics, circuitry, mountings, coil tables and information for ordering CLARE mercury-wetted contact relays.

See your nearest CLARE representative or address: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 840 Caledonia Road, Toronto 19, Ontario. Cable Address: CLARELAY.

**C. P. CLARE & CO.**

*Relays and related control components*

Circle 27 on Inquiry Card

# Tele-Tips

(*Continued from Page* 40)

miles with resultant complaints. Upon being warned about unlicensed operation, he promptly reported that he had dismantled the station and signed himself, "Engineer No-Longer-In-Charge."

**THE PORTLAND (OREG.) FIELD OFFICE** has had its share of problems with embryo broadcasters. One case involved the usual phonograph oscillator tied to an outdoor antenna for increased — and illegal — radiation. No sooner had this "station" been shut down than another youth fabricated a carrier current system which he thought would not cause trouble. However, the field engineer found excessive power line radiation. After a warning the boy's father said that operation had been suspended until the installation met radiation limitation requirements.

**THREE TEENAGERS** arrested for burglary in New Orleans were found to possess unlicensed radio equipment. Their ringleader had a highly advanced technical knowledge of electronics. His undoing came when he sent several messages on a stolen amateur transmitter. They were overheard and 30 minutes later the boy was in police custody, and two companions were picked up later.

**INTERFERENCE** was reported to electroencephalographs (instruments used to record brain waves) at veterans hospitals. A Chicago instrument was picking up programs of a local FM station. Inspection showed that the station was not at fault. The medical instrument was capable of acting as a radio receiver. Shielding it gave a truer picture of the patients' brain waves. FCC engineers also showed a Boston hospital how the same type of instrument was affected by a diathermy machine used in its clinic, for which the local FCC office received a letter of appreciation.

(*Continued on Page* 50)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the facts
about
readouts
readout fact finder
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PLAINFIELD, NEW JERSEY
This 14-page factual report compares the six major types of in-line readout devices from the standpoint of viewing distance, viewing angle, speed and method of operation, size, weight, power, cost, reliability and life.
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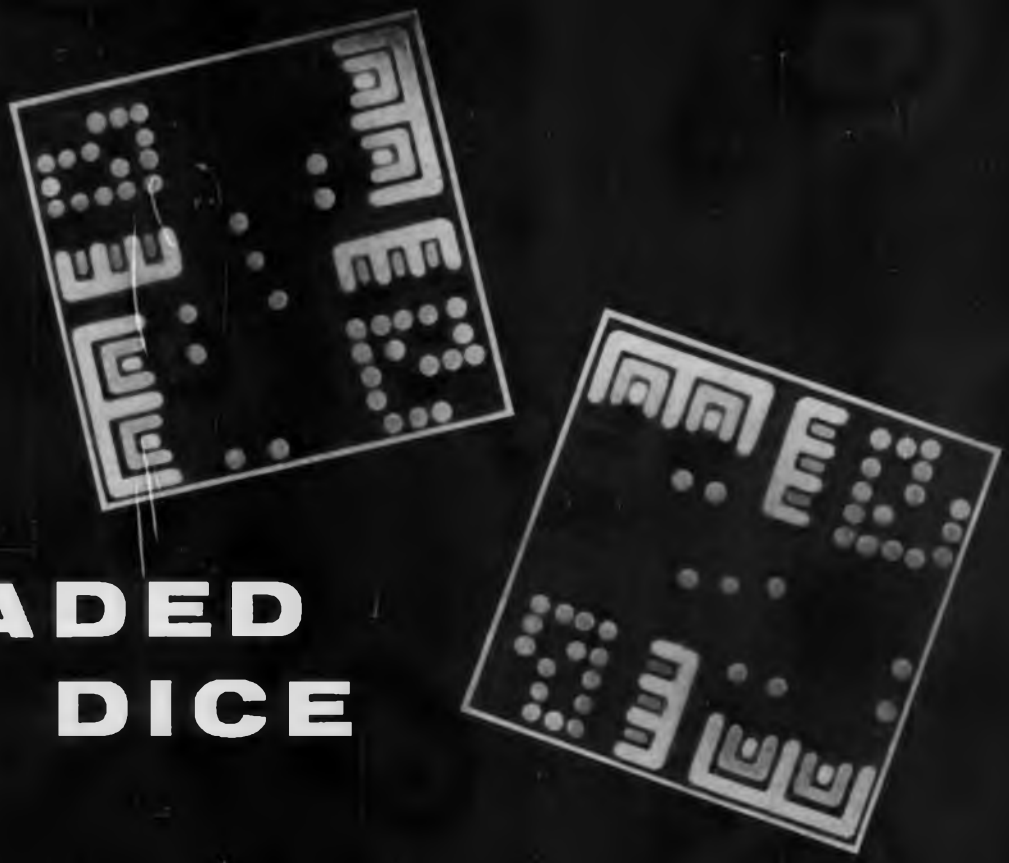
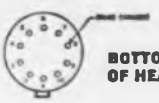


# LOADED DICE

## SEMI-NETS*

**SEMICONDUCTOR INTEGRATED NETWORKS**

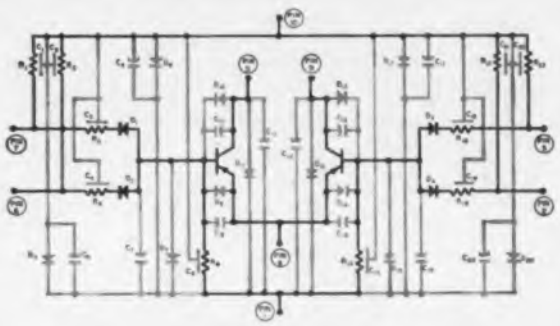
*TRADE MARK SPERRY RAND CORPORATION



BOTTOM VIEW OF HEADER

LEGEND
DESIGNED CIRCUIT
DISTRIBUTED CONSTANTS

NOTE: DIODES $D_9$, $D_{10}$, $D_{13}$, $D_{14}$ AND CAPACITORS $C_9$, $C_{10}$, $C_{13}$, $C_{14}$ ARE PORTIONS OF TRANSISTORS



## COMPLETE CIRCUIT ON A SILICON SLICE REDUCES ASSEMBLY COSTS . . . INCREASES CIRCUIT RELIABILITY.

Through the use of photoresists, planar diffusion, and surface passivation, the complete circuit, shown above, has been fabricated in one silicon slice — packaged in a multilead TO-5 case.

Because this high density device eliminates 75% of conventional connections, your circuit assembly costs are reduced. And because fewer interconnections mean less opportunity for circuit failure, your overall circuit reliability is increased.

In addition, SEMI-NETS offer design and systems engineers weight and volume reduction over conventional miniature components, between 100:1 and 1000:1. Low power requirements further the overall advantages of the SPERRY SEMI-NET.

If you are interested in the development of a SEMI-NET circuit for your equipment, we would like the opportunity to show you how we may help you.

Write today for comprehensive brochure describing the state of the art of SEMI-NETS.

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DIVISION OF
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Circle 30 on Inquiry Card

**SEMICONDUCTOR INTEGRATED NETWORKS (SEMI-NETS*), TUNNEL DIODES, MESA AND ALLOY SILICON TRANSISTORS AND DIODES**

SALES OFFICES: CHICAGO, ILLINOIS; LOS ANGELES, CALIFORNIA; OAKLAND, NEW JERSEY; MEDFORD, MASSACHUSETTS; SYKESVILLE, MARYLAND; FOREST HILLS, NEW YORK

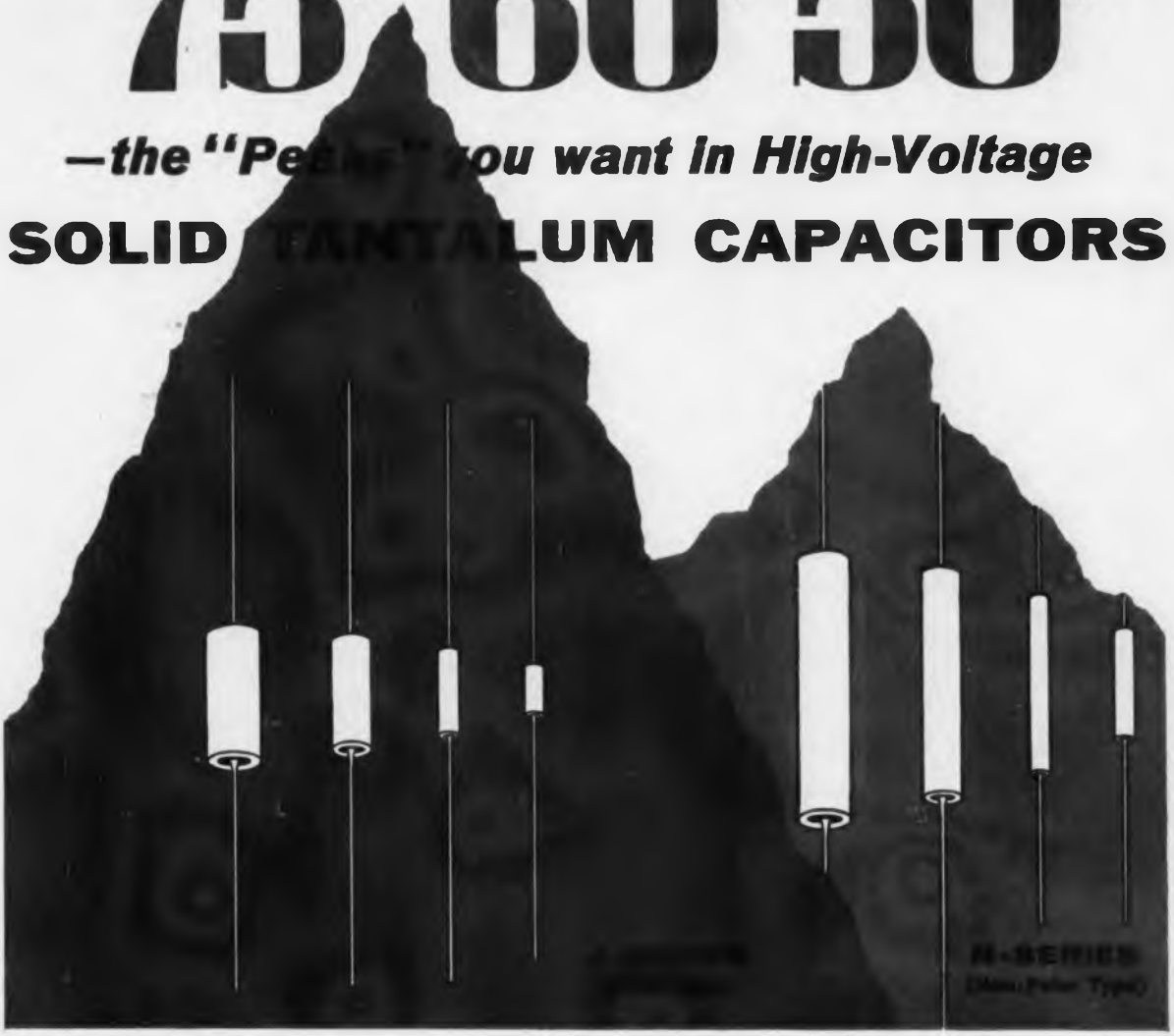
SEMICONDUCTOR OPPORTUNITIES AVAILABLE TO QUALIFIED ENGINEERS

*Trade Mark, Sperry Rand Corporation

# 75[V] 60[V] 50[V]

## —the "Pe[illegible]" you want in High-Voltage

## SOLID [illegible]TANTALUM CAPACITORS



## —EXCLUSIVE WITH KEMET

TRADE-MARK

Only KEMET can offer you the *widest* selection of dependable *high-voltage* solid tantalum capacitors. Topping the list is KEMET's new 75-volt type—*the highest rated working voltage unit of its kind available today—by a margin of 50%!*

KEMET's complete J-Series and N-Series comprise voltages of 60 and 50—ranging downward through 35, 20, 15, 10, and 6 volts—providing standard E.I.A. values with ±5%, ±10%, and ±20% tolerances.

J-Series capacitance values range from .0047 to 330 microfarads; operating temperatures from —55 to +125° C. N-Series capacitance values range from .0024 to 160 microfarads; operating temperatures from —55 to +105° C.

"KEMET" solid tantalum capacitors are designed, manufactured, and *tested* to serve the most demanding industrial/military applications. All are hermetically sealed in corrosion-resistant metal cans, with solderable and weldable leads. Four J-Series case sizes meet or exceed the performance requirements of MIL-C-26655A/2.

For utmost reliability in solid tantalum capacitors—*high or low voltage*—specify "KEMET". Kemet Company, Division of Union Carbide Corporation, 11901 Madison Avenue, Cleveland 1, Ohio.

Write for technical data on the complete line of "KEMET" Solid Tantalum Capacitors

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# When should you use Mercury-Wetted Contact Relays?


**IF YOUR RELAYS MUST**

**SWITCH UP TO 100 TIMES PER SECOND**

**HAVE A LIFE IN EXCESS OF A BILLION CYCLES**

**BE COMPLETELY RELIABLE AND FREE FROM CONTACT BOUNCE**

**THEN SPECIFY P&B MERCURY WETTED CONTACT RELAYS**

An unusual combination of advantages found only in mercury-wetted relays has led many design engineers to specify them for tough switching jobs. Here are but 3 typical characteristics of our JM series:

**RELIABILITY.** Sealed-in-glass mercury contacts are renewed with every operation. Won't pit or weld. Make or break is positive . . . every time. No bounce, no chatter. Signals ranging from a few micro amps to 5 amps are switched with singular consistency.

**LONG LIFE.** Think in terms of *billions* of operations when considering JM series relays. Proper application, of course, is a requisite.

**SPEED.** Operate time is just less than 3 milliseconds using 2 watts of power. Release time is about 3.2 milliseconds. Thus, relays can be driven 100 times per second.

If your project calls for exceptional relay performance, perhaps the answer lies in our JM Mercury-Wetted contact relay.

**JM SERIES ENGINEERING DATA**

**Contact Rating:**
5 amperes maximum
500 volt maximum
250 volt-amp max. with required contact protection.

**Contact Configuration:**
Each capsule SPDT. Combination of capsules in one enclosure can form DPDT, 3PDT, 4PDT. (All Form D.)

**Terminals:**
Plug-in or hook solder; 8, 11, 14, or 20-pin headers.

**Coil Resistance:**
2 to 58,000 ohms.

*More information?*
Write today for free catalogue.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

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# THESE 6 NEW MOTOROLA EPITAXIAL MESA SWITCHES REPLACE MICRO-ALLOY, DRIFT and OTHER MESA TYPES

ACTUAL SIZE

REPLACEMENT CHART*

| Process Group | 2N960 | 2N961 | 2N962 | 2N964 | 2N965 | 2N966 |
|---|---|---|---|---|---|---|
| Micro-alloy Diffused | 2N501<br>2N846<br>2N588<br>2N1500 | 2N769<br>2N768 | 2N1499A | 2N779 | — | — |
| Mesa | 2N781<br>2N705<br>2N710 | 2N711 | 2N782 | 2N1301<br>2N795<br>2N1683<br>2N934 | — | 2N1300<br>2N794 |
| Micro-alloy | 2N1122A | 2N1122 | 2N393<br>2N1427<br>2N1411 | — | — | |
| Surface Barrier | — | 2N128 | 2N210<br>2N344<br>2N345<br>2N346 | — | — | — |
| Alloy | 2N583 | — | — | 2N582<br>2N584 | — | — |
| Drift | — | 2N643<br>2N844<br>2N645 | 2N1450<br>2N602 | — | 2N609 | 2N603 |

*Interchangeability of types shown is on the basis of performance in most switching circuit applications.

## for improved performance of both old and new designs

This new Motorola germanium epitaxial switching series – the 2N960-62, 2N964-66 – will supplant nearly all other germanium micro-alloy, drift, mesa, and other transistor types for high-speed switching applications . . . in many cases at considerably lower prices.

In comparison with the older devices, these six new universal switching transistors offer major design advantages that contribute to improved performance of both old and new designs.

- faster switching time ($T_{RS}$ = 0.6 nsec)
- guaranteed minimum Beta over wide current range . . . specified at 10, 50 and 100 mA
- low saturation voltage even at 100 mA
- rugged Mesa construction
- the most comprehensive published specifications of any similar switching transistors
- proven reliability from the world's largest manufacturer of germanium epitaxial transistors

For applications where the advantages offered by this new epitaxial series are not essential, Motorola also offers eight new non-epitaxial germanium mesa transistors – the 2N968-75 series – at even lower prices.

| MOTOROLA GERMANIUM EPITAXIAL SWITCHING TRANSISTORS | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2N960 | 2N961 | 2N962 | 2N964 | 2N965 | 2N966 | UNITS |
| $h_{FE}$ min<br>10, 50, 100 mA | 20 | 20 | 20 | 40 | 40 | 40 | — |
| $V_{CE(SAT)}$ max<br>@ 10 mA | .20 | .20 | .20 | .18 | .18 | .18 | Volts |
| @ 50 mA | .40 | .40 | .40 | .35 | .35 | .35 | Volts |
| @ 100 mA | .70 | .70 | .70 | .60 | .60 | .60 | Volts |
| $f_T$ min<br>$I_C$=20 mAdc<br>$V_{CB}$=1.0 Vdc | 300 mc all types | | | | | | |
| $Q_T$ max<br>$I_C$=10 mAdc<br>$I_B$=1 mAdc | 80 | 80 | 90 | 80 | 80 | 90 | pc |
| $I_C$=100 mAdc<br>$I_B$=5 mAdc | 125 | 125 | 150 | 125 | 125 | 150 | pc |
| $T_{RS}$ | 0.6 nsec typical all types | | | | | | |
| $T_{PS}$ | 0.5 nsec typical all types | | | | | | |
| All types have 150 mW dissipation in free air, 300 mW at 25°C case temperature | | | | | | | |

**FOR MORE INFORMATION** on either of these important new mesa series, contact your Motorola District Office, or call or write: Motorola Semiconductor Products Inc., Technical Information Department, 5005 East McDowell Road, Phoenix 8, Arizona.

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## Tele-Tips

(*Continued from Page* 44)

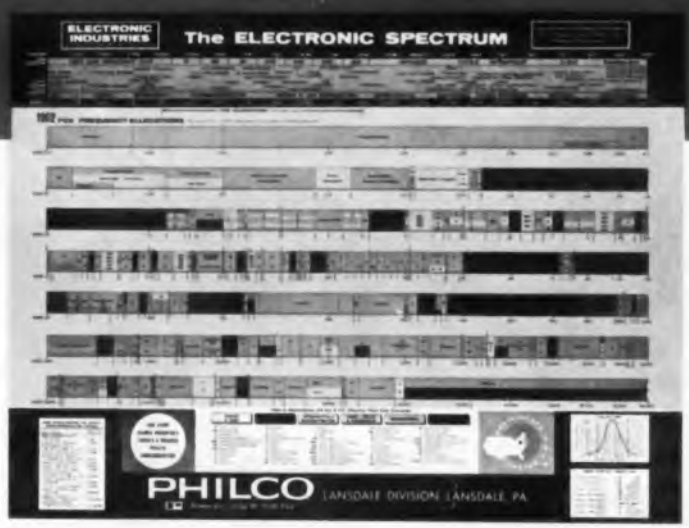
**RADIO INTERFERENCE** can hop-skip over great distances: The West German monitoring service asked for identification of strange messages which seemed to be in Japanese. The FCC monitoring network determined that the signals were sent by a system adaptable for transmitting Chinese characters. They were found to come from a station near Peking, China.

**A GOVERNMENT** satellite-tracking station in Alabama sent an urgent call to the FCC monitoring station at Powder Springs, Ga., that interference was knocking out reception of transmission from Iota I. The Kingsville, Texas, station had already alerted the monitoring net to the same disturbing signal. The culprit was found to be a transmitter near Madrid, Spain. Contact with the Spanish government resulted in spurious emissions being eliminated.

**"ROUGH NOISE"** on broadcast reception sent Arizona monitoring station engineers on a turkey hunt. The complainant accused a neighbor, an amateur operator. However, the latter's transmitter was in the repair shop. So the FCC investigators next tried an electrical plant. Here there was plenty of noise but no electrical disturbance. So the searchers moved on to another possible source—a turkey farm. There they found a loose power line connection to a large pump. The electric power company made quick repair.

**DALLAS FIELD ENGINEER** visited the home of a citizens radio licensee, who was the subject of numerous complaints, he found the walls plastered with cards attesting to his efforts to get "distant" reception, which is prohibited. The licensee insisted on returning his license to the FCC engineer, stating that it had given him too much trouble and that he proposed to try for an amateur license so that he could engage in the "DX" type of operation in which he is primarily interested.

# YOUR NEW 1962 WALL-SIZE ELECTRONIC SPECTRUM

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*MICRO ALLOY DIFFUSED-BASE TRANSISTORS

**SPAT***

*SILICON PRECISION ALLOY TRANSISTOR

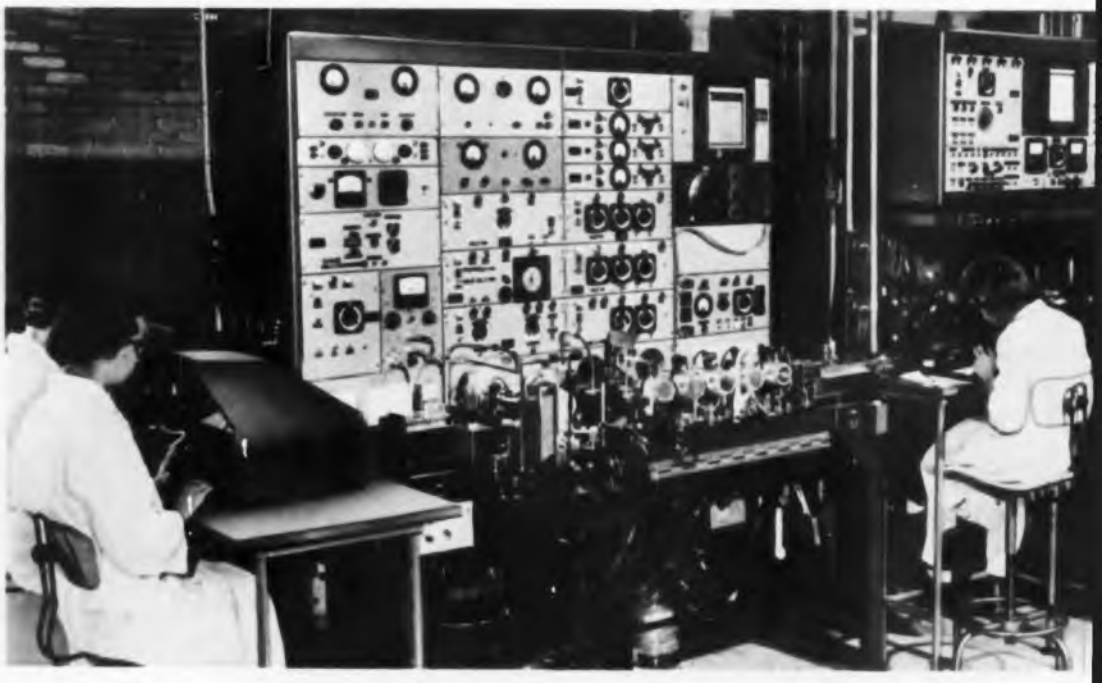
# THIS IS THE FAMOUS PHILCO FAST* LINE... INDUSTRY'S FIRST AND FINEST AUTOMATION FOR TRANSISTORS... KEY TO PRECISION AND UNIFORMITY!

*FAST AUTOMATIC SEMICONDUCTOR TRANSFER

**EPITAXIAL**
**SILICON MESA TRANSISTORS**

**MCP* CIRCUITS**
*MULTI-COMPONENT PACKS.

MICROWA
SWITCHES



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## PHOTOSENSORS

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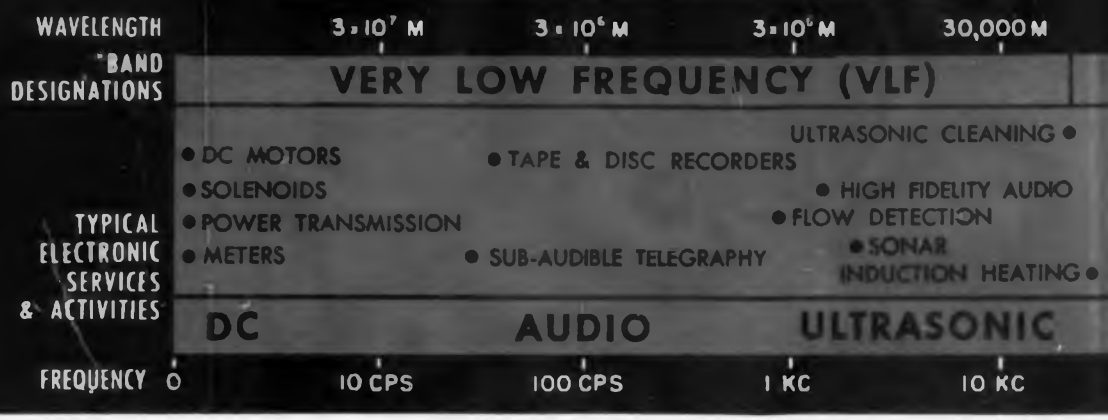
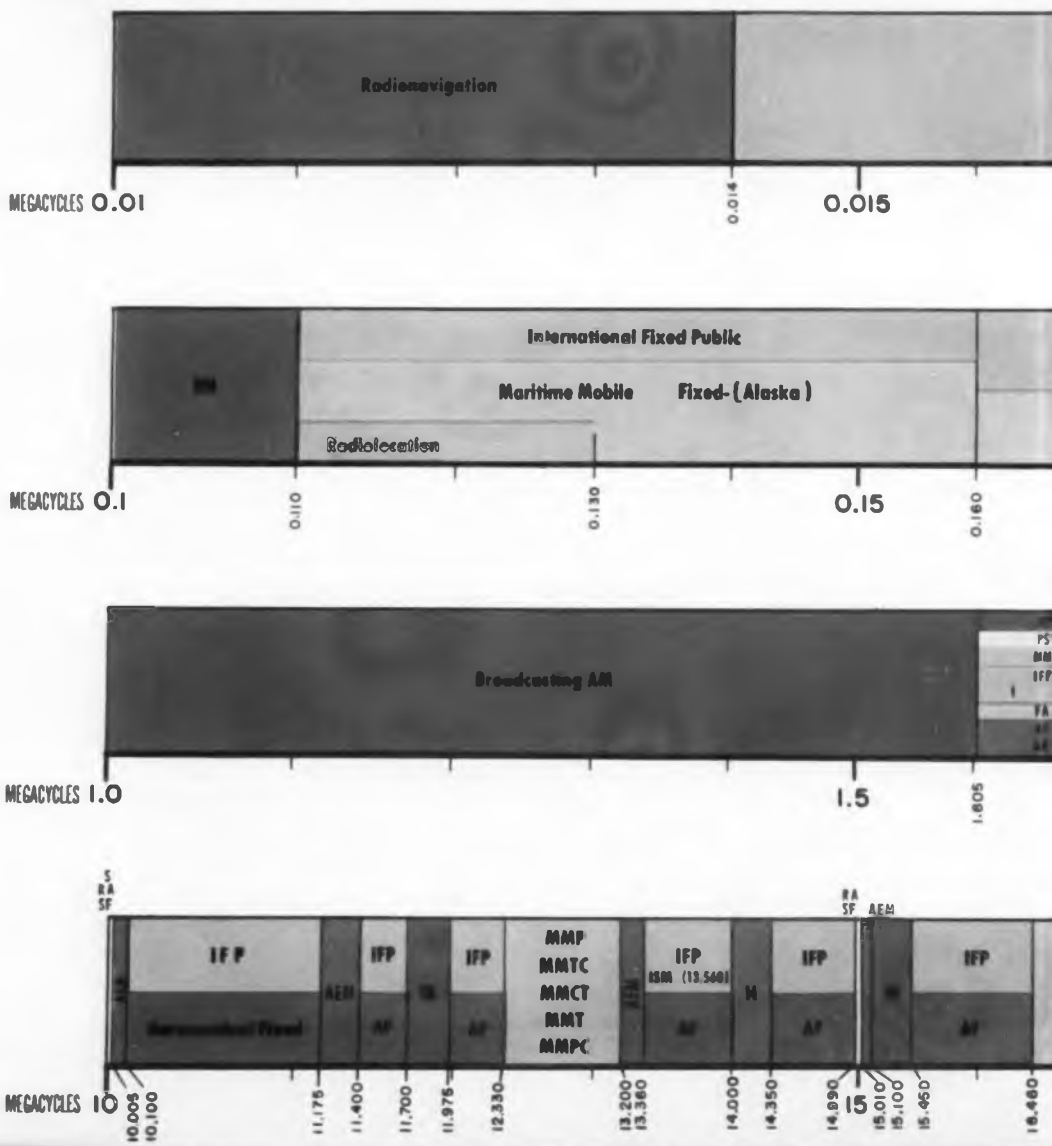



# 1962 FCC FREQUENCY ALLOCATION

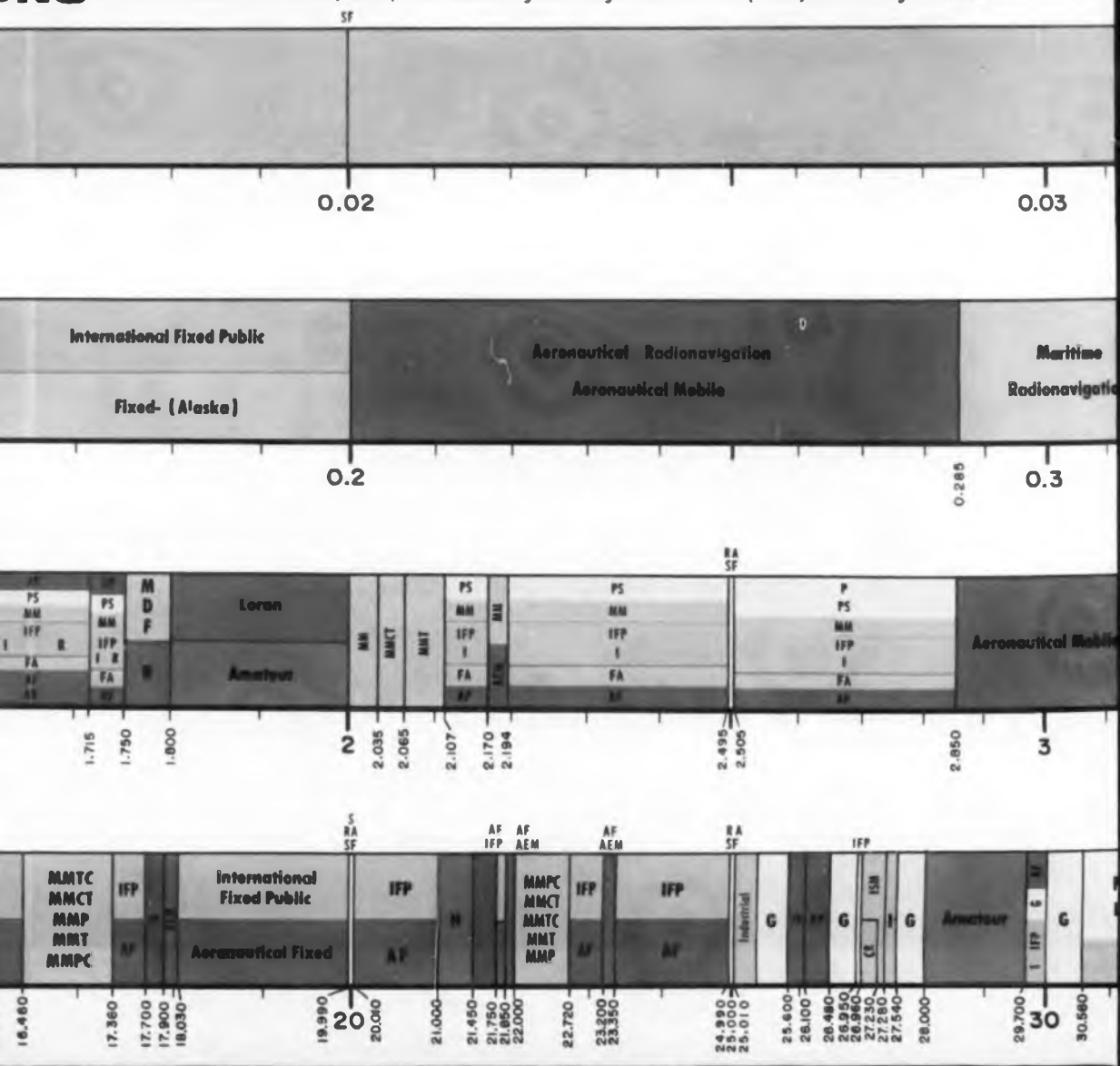


# The ELECTRO

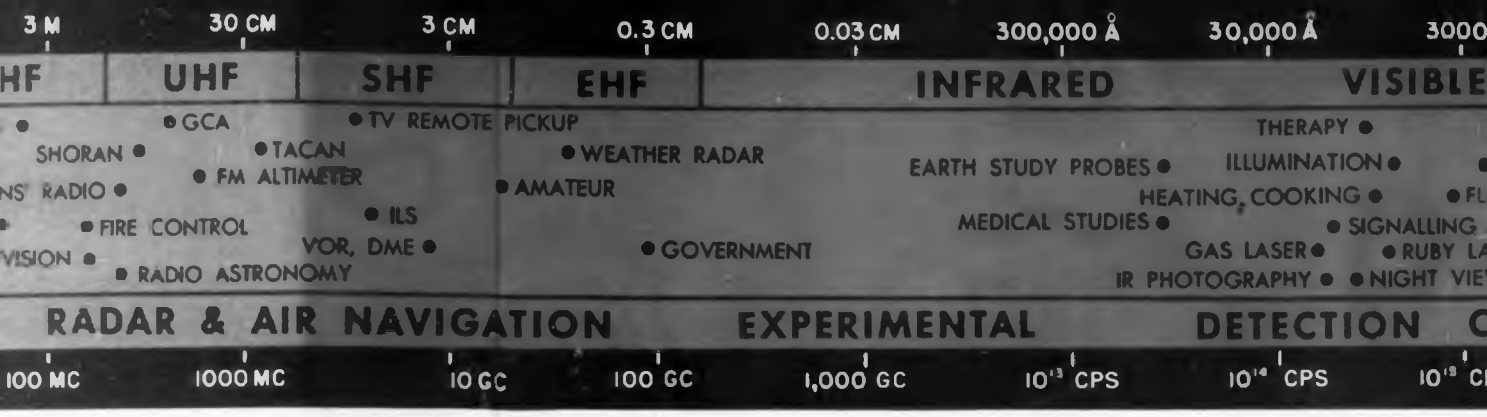

## FCC ALLOCATIONS (See details below)

## ONS

*Data corrected to Jan. 1, 1962; includes changes to align with Geneva (1959) Radio Regulations.*

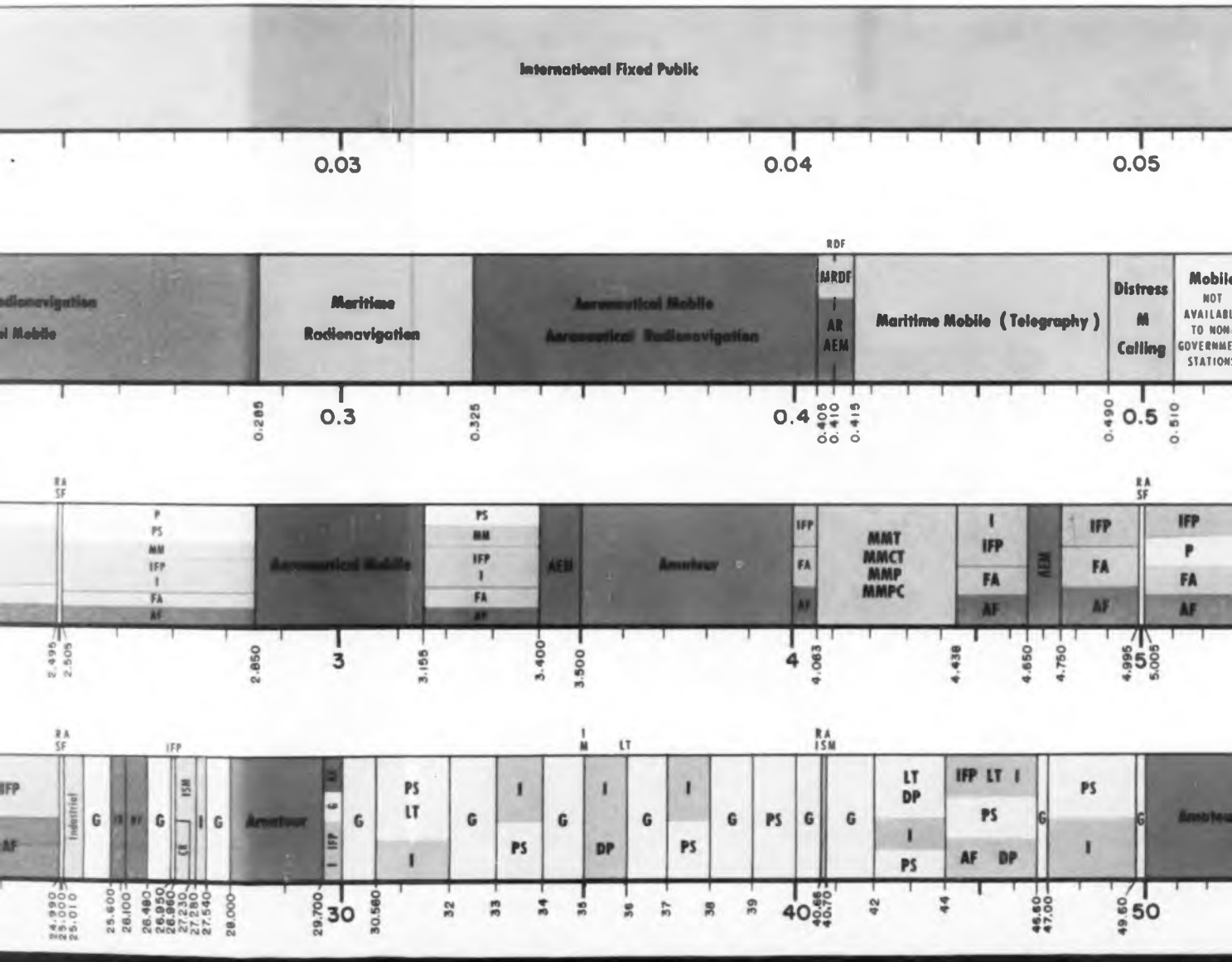


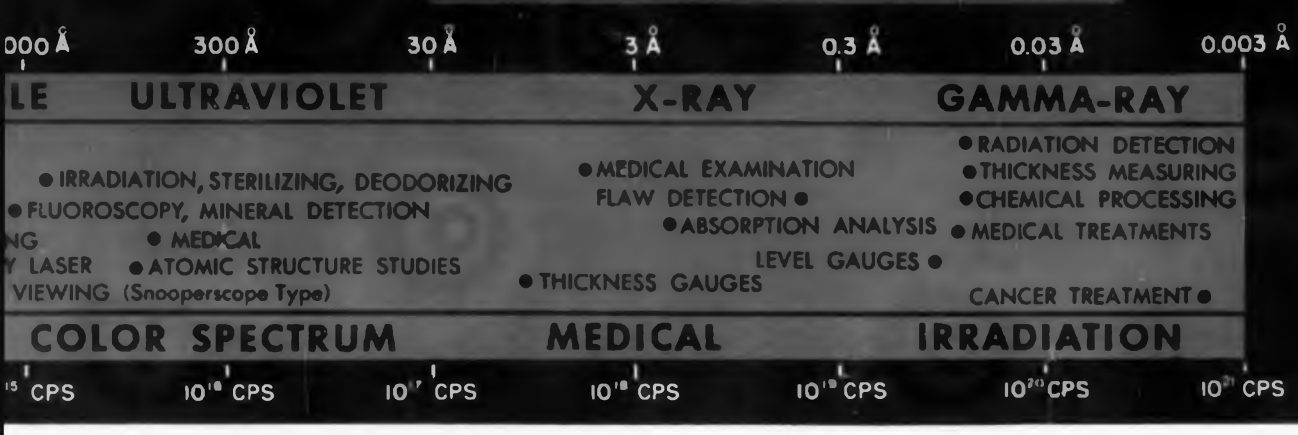
# ECTRONIC SPECTRU

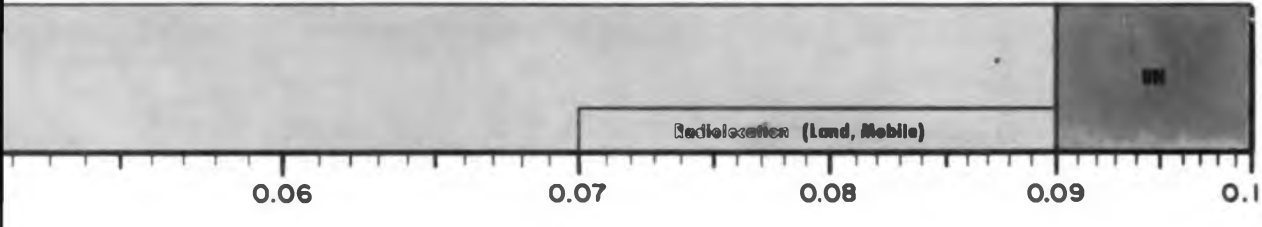



(See details below)

Geneva (1959) Radio Regulations.




300 Å
30 Å
3 Å
0.3 Å
0.03 Å
0.003 Å
ULTRAVIOLET
X-RAY
GAMMA-RAY
● IRRADIATION, STERILIZING, DEODORIZING
● FLUOROSCOPY, MINERAL DETECTION
● MEDICAL
● ATOMIC STRUCTURE STUDIES
VIEWING (Snooperscope Type)
● MEDICAL EXAMINATION
FLAW DETECTION ●
● ABSORPTION ANALYSIS
LEVEL GAUGES ●
● THICKNESS GAUGES
● RADIATION DETECTION
● THICKNESS MEASURING
● CHEMICAL PROCESSING
● MEDICAL TREATMENTS
CANCER TREATMENT ●
COLOR SPECTRUM
MEDICAL
IRRADIATION
10¹⁸ CPS
10¹⁷ CPS
10¹⁸ CPS
10¹⁹ CPS
10²⁰ CPS
10²¹ CPS


Radiolocation (Land, Mobile)
0.06
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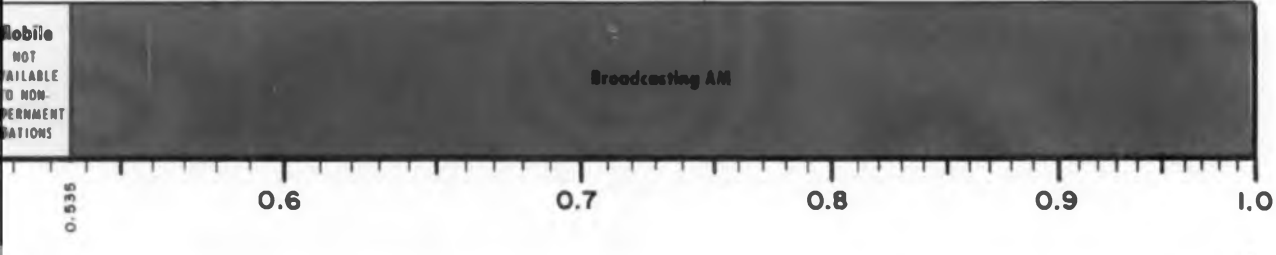
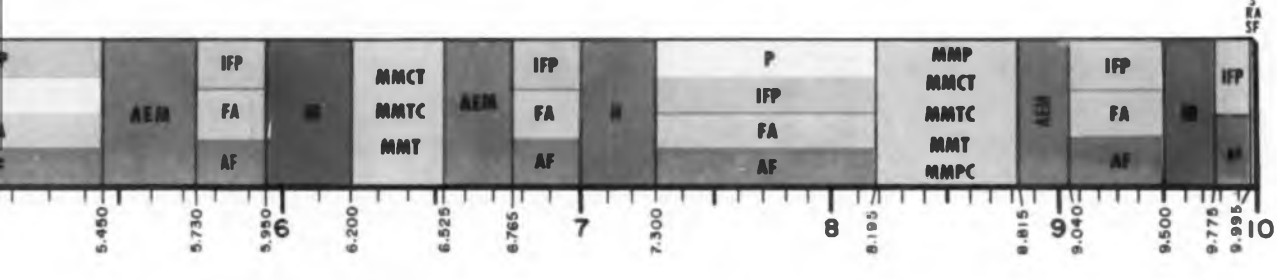
0.09
0.1


Broadcasting AM
0.535
0.6
0.7
0.8
0.9
1.0


AEM
IFP
FA
AF
MMCT
MMTC
MMT
P
MMP
MMPC
5.450
5.730
5.950
6
6.200
6.525
6.765
7
7.300
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8.195
8.815
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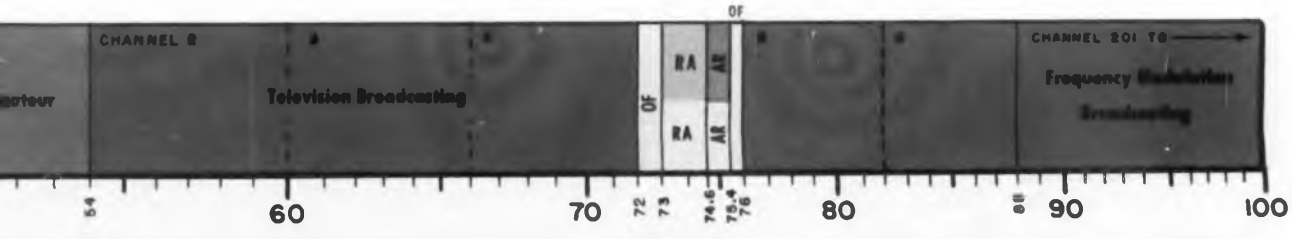
9.040
9.500
9.775
9.995
10


CHANNEL 2
Television Broadcasting
CHANNEL 201 TO
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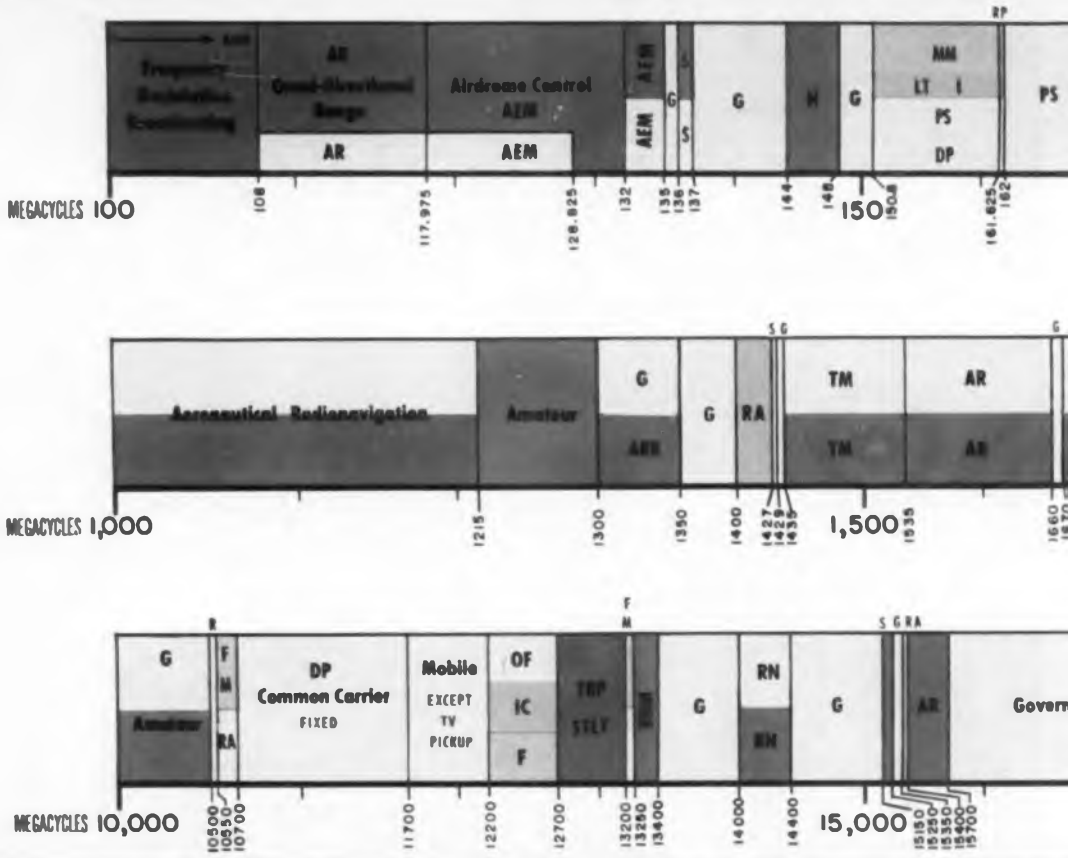
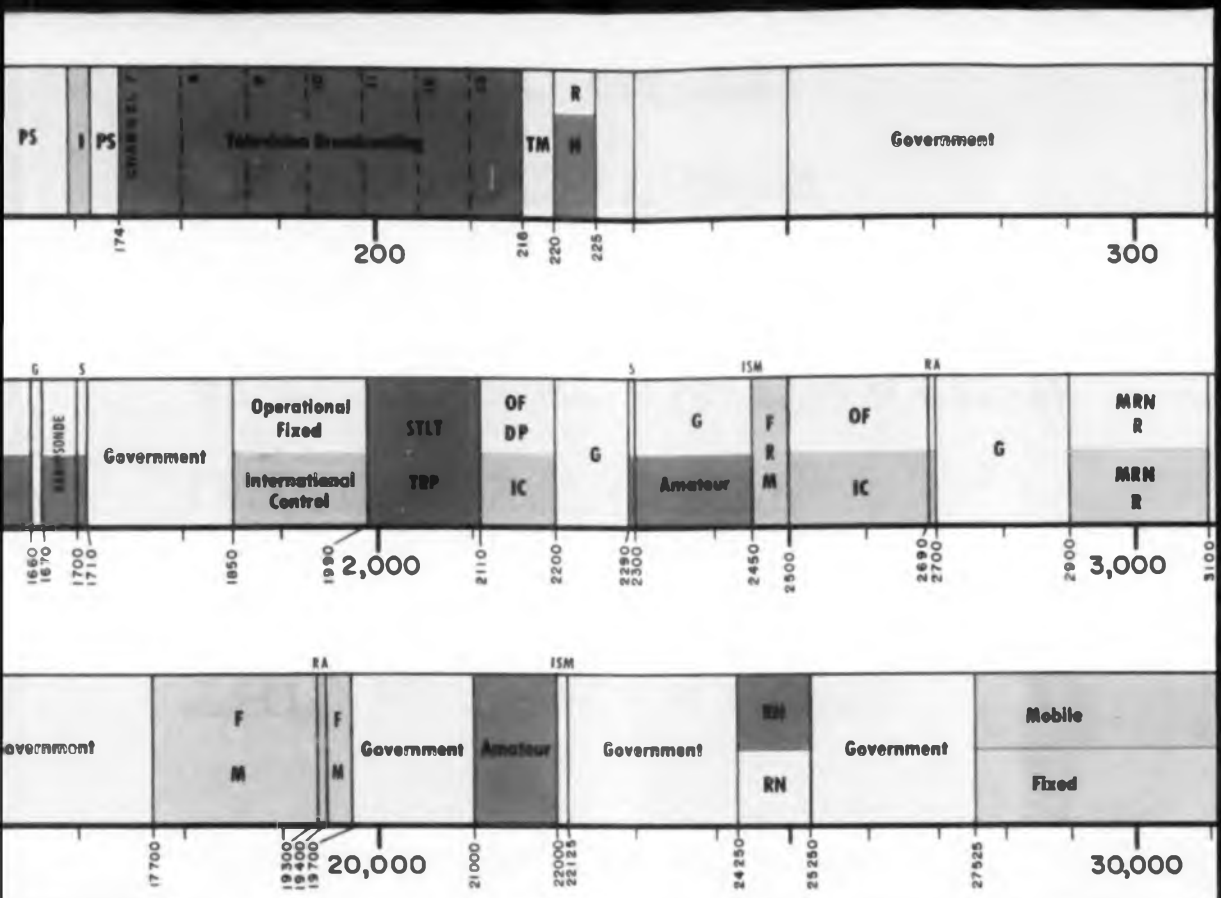


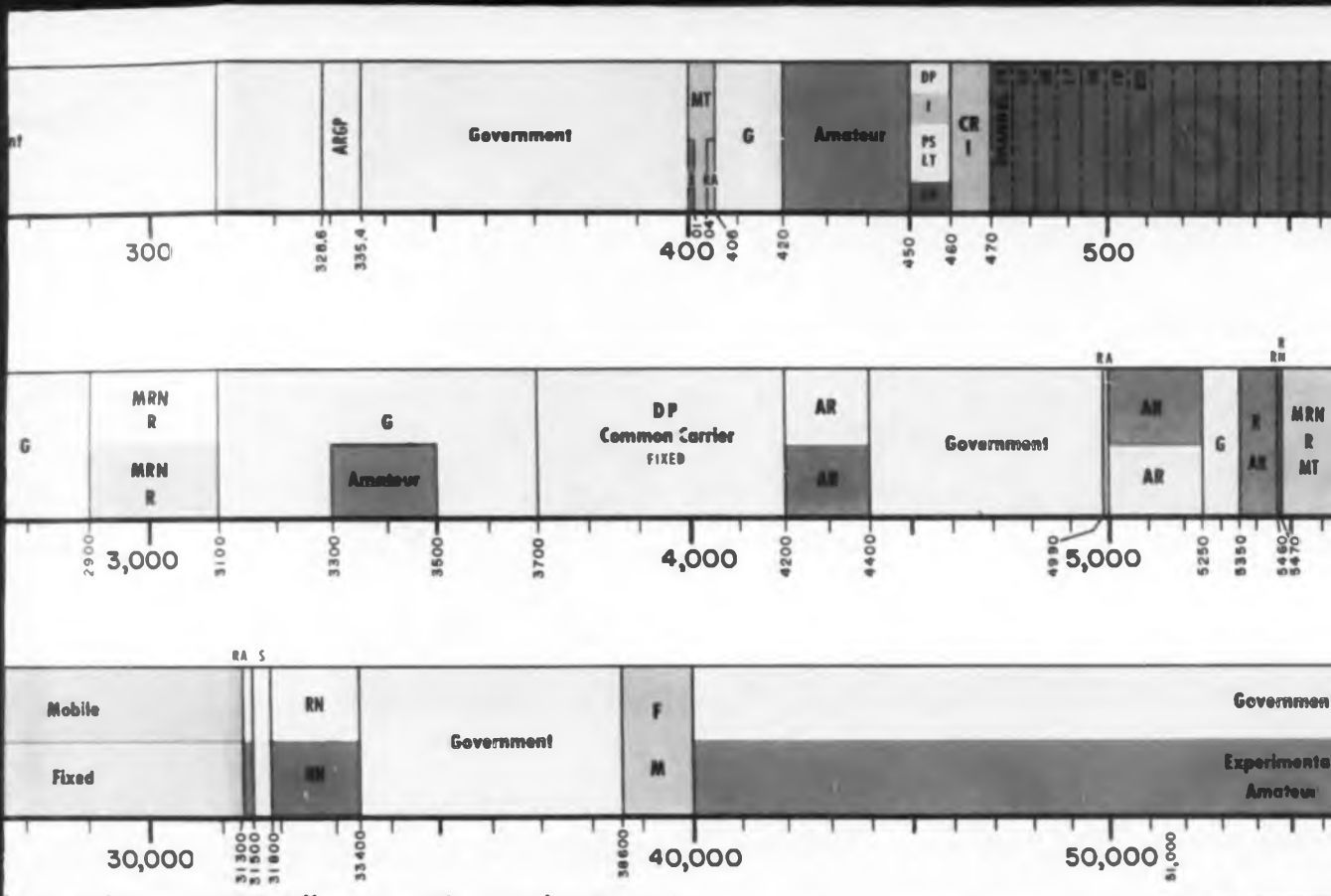

**BAND WIDTHS REQUIRED FOR VARIOUS RADIO-COMMUNICATION SERVICES**

| *Kind of Service* | *Typical Band Widths, cps* |
|---|---|
| Keyed Telegraphy—manual (25 wds/min) | 0-100 |
| Frequency shift telegraphy | 0-1,800 |
| Tone-modulated telegraphy (25 wds/min, 1,000 cps tone) | 0-2,100 |
| Telephony, commercial (ssb) | 0-3,000 |
| Facsimile, 8x10 in., 100 lines/in. transmitted with 1,000 cps tone | 0-4,000 |
| Telephony, commercial (DSB) | 0-6,000 |
| Telephony, high quality SSB | 0-5,000 |
| Telephony, high quality DSB | 0-10,000 |
| FM Facsimile, 8x10 in. pix, transmitted with 1,000 cps tone | 0-14,000 |
| Telephony, exceptionally high quality SSB | 0-20,000 |
| Telephony, frequency modulated | 0-36,000 |
| Telephone broadcasting, FM, high quality | 0-200,000 |
| Television, commercial (525 lines, 30 frames/sec) | 30-4,350,000 |
| High-definition television (1,029 lines, 30 frames/sec) | 30-16,650,000 |




## *Index to Abbreviations and Key to F*

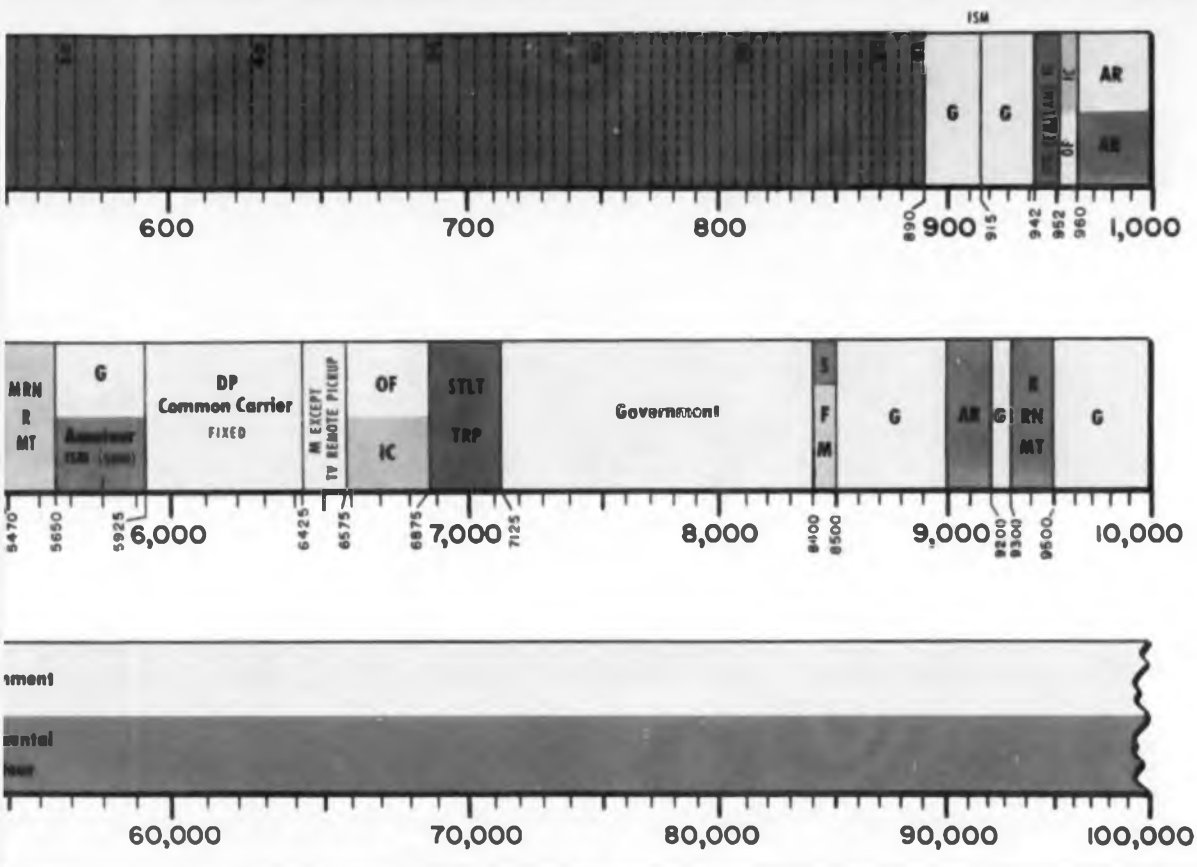
| MARINE & FIXED | BROADCASTING | AERONAUTICAL & RADIONAVIGATION |
|---|---|---|
| **AC** Airdrome Control | **EX** Experimental | **L** Loran |
| **AEM** Aeronautical Mobile | **F** Fixed | **LT** Transportation |
| **AF** Aeronautical Fixed | **FA** Fixed-(Alaska) | **M** Mobile |
| **AR** Aeronautical Radionavigation | **FM** Frequency Modulation Broadcasting | **MM** Maritime Mobile |
| **ARGP** Aeronautical Radionavigation Glide Path | **G** Government | **MMCT** Maritime Mobile Co |
| **ARR** Aeronautical Radionavigation Radar | **H** Amateur | **MMP** Maritime Mobile Ph |
| **BAM** Broadcasting AM | **I** Industrial | **MMPC** Maritime Mobile Ph |
| **CC** Common Carrier | **IB** International Broadcasting | **MMPDC** Maritime Mobile Ph |
| **CR** Citizens Radio | **IC** International Control | **MMT** Maritime Mobile (Te |
| **D** Disaster | **IFP** International Fixed Public | **MMTC** Maritime Mobile Te |
| **DP** Domestic Public | **ISM** Industrial, Scientific, Medical | **MRN** Maritime Radio Nav |



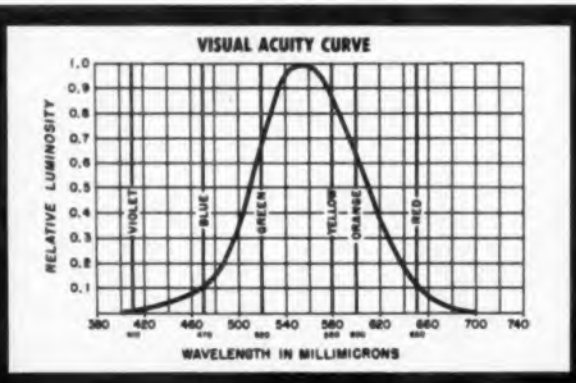

## ...ions and Key to FCC Allocation Chart Color Groupings

**...RONAUTICAL & ...DIONAVIGATION** | **PUBLIC SERVICE & GOVERNMENT** | **MISCELLANEOUS** | **EXPERIMENTAL & AMATEUR**

| | | | | | |
|---|---|---|---|---|---|
| **L** | Loran | **MT** | Meteorological Aids | **RP** | Remote pickup broadcast |
| **LT** | Transportation | **(NIB)** | Non-Interference Basis | **S** | Space and Earth-Space |
| **M** | Mobile | **OF** | Operational Fixed | **SF** | Standard Frequency Transmission |
| **MM** | Maritime Mobile | **OR** | Omni-Directional Radio Range | **STL(AM)** | Studio-Transmitter Link (for AM Transm.) |
| **MMCT** | Maritime Mobile Coastal (Telegraphy) | **P** | Police | **STL(FM)** | Studio-Transmitter Link (for FM Transm.) |
| **MMP** | Maritime Mobile Phone | **PS** | Public Safety | **STLT** | Studio Transmitter Link-TV |
| **MMPC** | Maritime Mobile Phone Coastal | **R** | Radiolocation | **TM** | Telemetering |
| **MMPDC** | Maritime Mobile Phone Distress and Calling | **RA** | Radio Astronomy | **TRP** | TV Remote Pickup |
| **MMT** | Maritime Mobile (Telegraphy) | **RDF** | Radio Direction Finding | **TV** | Television Broadcasting |
| **MMTC** | Maritime Mobile Telegraphy Calling | **RN** | Radionavigation | **TVSTA(A)** | TV Studio-Transmitter Link (for Audio) |
| **MRN** | Maritime Radio Navigation | **RNM** | Radionavigation Mobile | | |




SOLID-STATE CENTER U.S.A. TM




**COMMON DESIGNATIONS of FREQUENCY BANDS**

P-band – 225-390 MC (133.3-76.9 cm)
L-band – 390-1550 MC (76.9-19.3 cm)
S-band – 1550-5200 MC (19.3-5.77 cm)
X-band – 5200-10,900 MC (5.77-2.75 cm)
K-band – 10,900-36,000 MC (2.75-0.834 cm)
Q-band – 36,000-46,000 MC (0.834-652 cm)
V-band – 46,000-56,000 MC (0.652-0.536 cm)

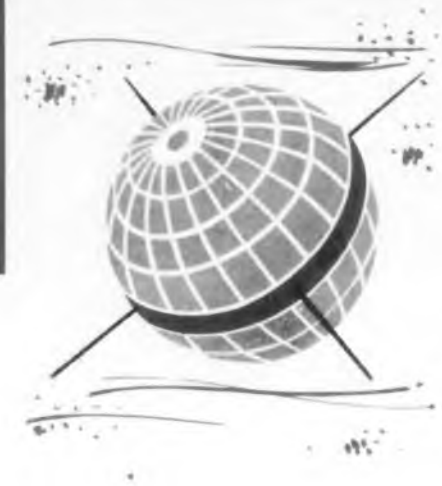
| | |
|---|---|
| VLF | to 30 kc |
| LF | 30-300 kc |
| MF | 300-3000 kc |
| HF | 3000-30,000 kc |
| VHF | 30,000 kc-300 mc |
| UHF | 300-3000 mc |
| SHF | 3000-30,000 mc |
| EHF | 30,000-300,000 mc |

**UNITS OF LENGTH**

1 meter = 3.281 feet
1 inch = 2.540 centimeters
1 cm = $10^8$ angstroms (Å)
1 cm = $10^4$ microns ($\mu$)

ALE, PA.

# THERE'S A PHILCO SOLID-STA
# FOR EVERY USABL



IN COMMUNICATIONS

IN COMPUTING

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# ATE COMPONENT
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IN INFRARED DETECTION

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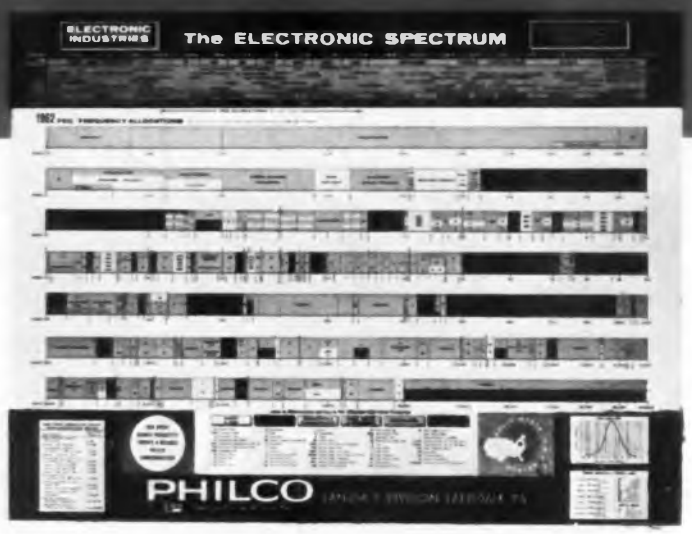
IN THIS FOLDOUT . . .

# YOUR NEW WALL-SIZE 6-COLOR ELECTRONIC SPECTRUM

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**PHILCO®**

*Famous for Quality the World Over*

Lansdale Division • Lansdale, Pennsylvania

SOLID-STATE U.S.A. CENTER

## *Telemetry Equipment Contact Awarded*

Pulse Code Modulation (PCM) telemetry and special data handling equipment for NASA's "Orbiting Astronomical Observatory" (OAO) satellite will be supplied by Radiation, Inc., Melbourne, Fla., under a subcontract issued by Grumman Aircraft Engineering Corp. The subcontract is expected to be in excess of $1 million. Grumman is prime contractor and systems manager of the OAO project.

OAO is a precisely stabilized 3,300 pound satellite designed to perform a variety of vital astronomical experiments. Basic objective of the OAO program is to create a standardized spacecraft which can be used for many scientific missions with only minor changes. First OAO is to be launched from the Atlantic Missile Range in late 1963. In the initial experiment, the OAO is to be used for stellar astronomy in the ultra-violet light range. The system will have an extremely high "Satisfactory Operating Probably" of 98%, in order to function in a space environment for one year or more.

## *Mobile Repair Shop For BIRDIE System*

U. S. Army Signal Support Agency, Fort Monmouth, N. J., recently demonstrated a mobile repair shop that automatically tests 75 electronic circuits a minute and tells which are defective. Shop was designed by Robert N. Boulle for easy maintenance of the BIRDIE air-defense system. The BIRDIE system a junior version of the Missile Master and is designed for defense of medium and small cities. Heart of the maintenance system is a ROBOTESTER, designed and built by Lavoie Laboratories, Morganville, N. J.

Nine shelters have been assembled under the Signal Corps Quick Reaction Program at Tobyhanna Signal Depot, Tobyhanna, Pa., where already available Signal test and repair equipment was mounted in standard 45 foot Ordnance vans. Self-sustaining van is air-conditioned and has its own heating unit. It requires no indoor facilities, and carries a 45-day supply of spare parts.

It is normally used with commercial power facilities, but has its own power generator for emergencies. Because of the automatic equipment, a minimum of training is necessary for repair personnel.

PERFORMANCE RELIABILITY WITHOUT COMPROMISE

# FOR ON-COURSE GUIDANCE

Reeves

MINIATURE

INERTIAL REFERENCE

# GYROS

## 12IG

The ultimate in miniaturization
Trimmed drift rate: 0.1 degrees/hour
Size: 2.5 inches by 1.25 inches
Weight: 5.5 ounces
Angular momentum: 31,600 cgs units
The ideal unit for miniature stable platforms


## ·ZERO·ONE

The finest inertial gyro available
Trimmed drift rate: 0.01 degrees/hour
Size: 2.8 inches by 2.0 inches
Weight: 0.7 pounds
Angular momentum: 280,000 cgs units

**These Reeves fully floated miniature integrating Gyros are the most painstakingly engineered and most precisely tested instruments available today for inertial reference and stable platform applications.**

**Reeves' achievements in the high-precision gyro field consistently emphasize reliability without compromise... and by this we mean that Reeves Gyros are rugged, dependable components produced in quantity to meet rigidly defined performance criteria. Beryllium floats and housings. For complete information, write for Data File 312.**

*Qualified engineers seeking rewarding opportunities in these advanced fields are invited to get in touch with us.*

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**REEVES INSTRUMENT CORPORATION**
*A Subsidiary of Dynamics Corporation of America*
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9RV61R

# Quality is a quantity of built-in values

If you measure electrical connector quality as we do—that is, by adding up ALL of the extras—we talk the same language. We believe you can't stint in even the smallest detail and come up with dependable quality.

Electrical connectors are vital components. They can affect the operation of the simplest power line . . . or the success of a million-dollar missile shot, a submarine trip under the polar ice cap, or a Mach 3 aircraft test. That's why Bendix builds the utmost quality into electrical connectors. In our book, there's no place for the smallest deviation in quality. To achieve closest quality control, we maintain one of the highest ratios of inspectors-to-production-workers in the industry.

Ask our customers about us. We're sure they will tell you that no one in the industry produces higher quality than does Scintilla Division. That's why Bendix® Electrical Connectors are most often selected for the most demanding jobs.

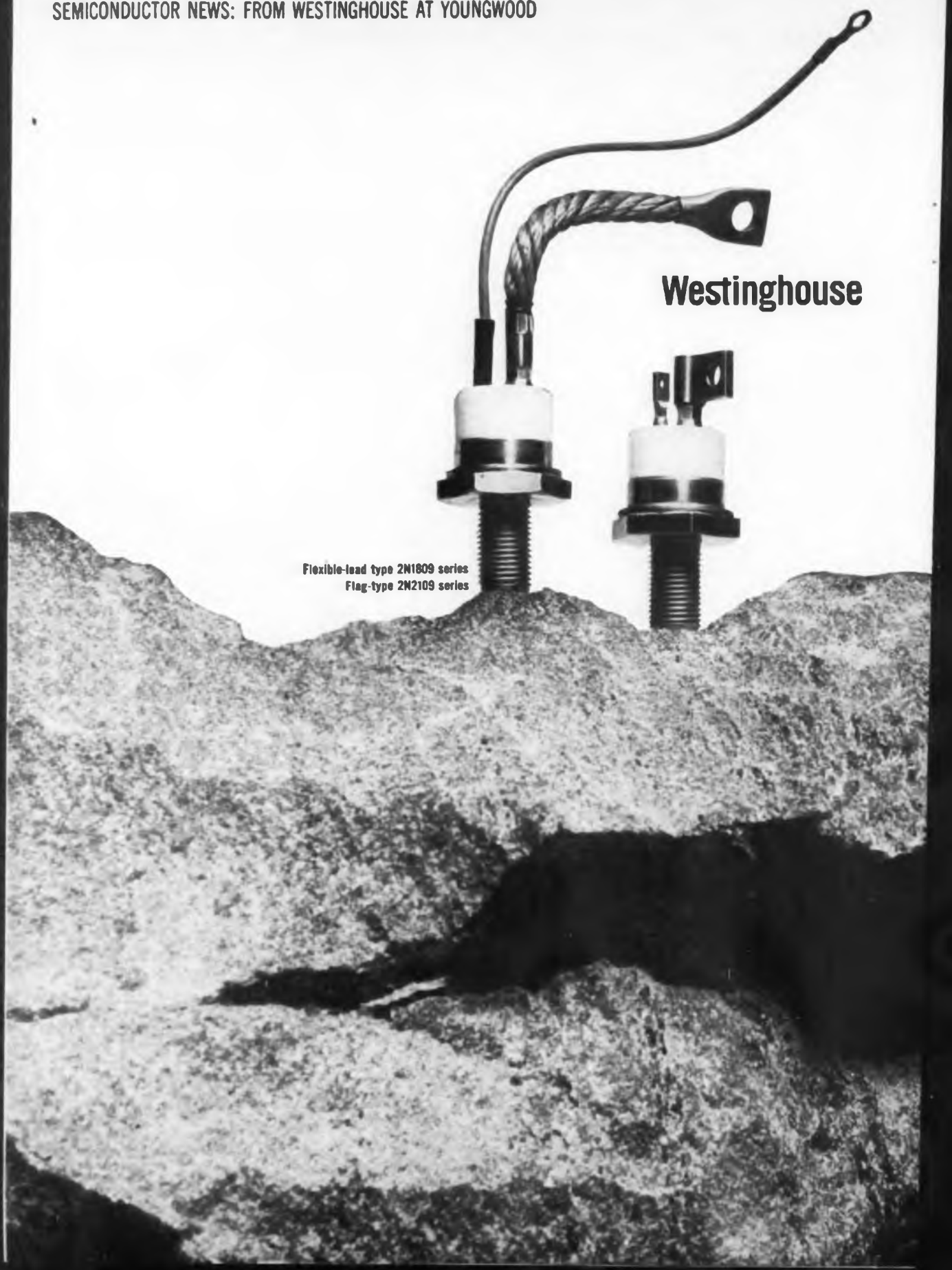
Integrity. Ability. Experience. Acceptance. They add up to a complete "package" of built-in quality values we think you will appreciate. And, this superior "package" is competitively priced. If you want to know more about our quality in quantity, call us at Sidney, N.Y.

**Scintilla Division**

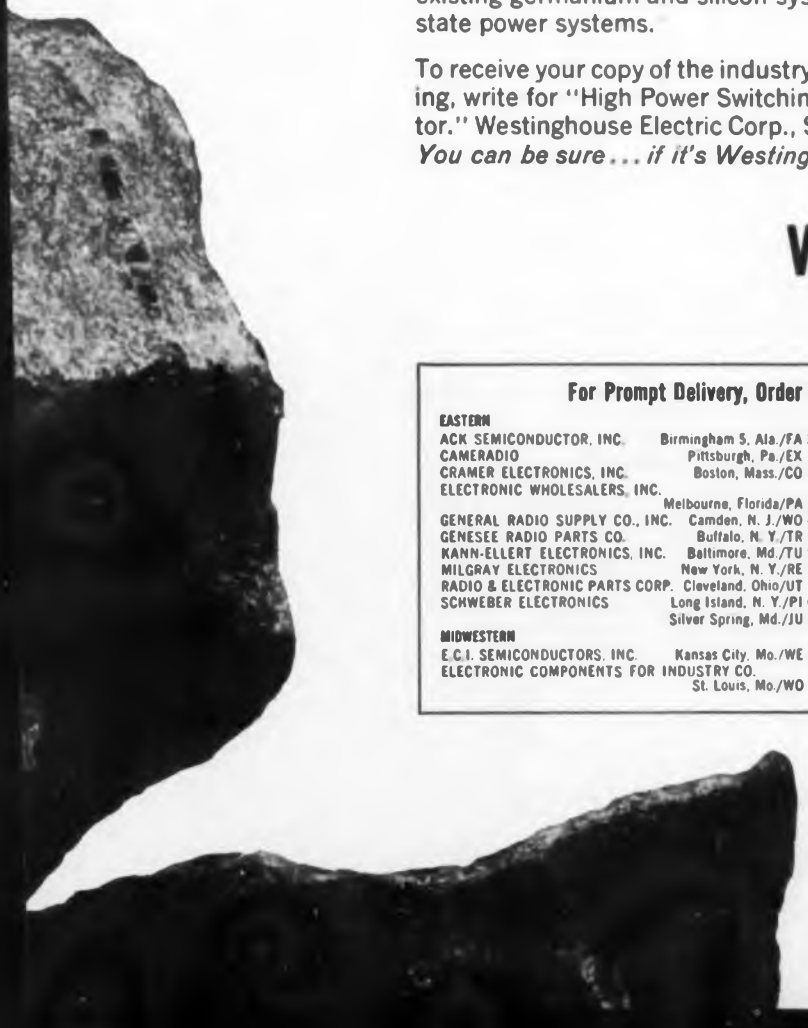
THE Bendix CORPORATION

Canadian Affiliate: Aviation Electric, Ltd., 200 Laurentien Blvd., Montreal 9, Quebec. Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.

SEMICONDUCTOR NEWS: FROM WESTINGHOUSE AT YOUNGWOOD



# announces higher ratings in 30-amp "Rock Top" Transistors



Westinghouse now brings you 30-ampere "Rock-Top" Transistors with higher ratings (200 volts), higher junction temperatures (175°C.), and lower saturation resistance (0.037 ohms). These improved ratings, coupled with the absence of secondary breakdown, mean dramatic three-fold increases in power-handling capabilities.

These transistors are available in production quantities in the flexible-lead Jedec 2N1809 series and the newly announced Jedec 2N2109 series with flag-type terminals. Both feature exclusive Westinghouse quality assurance with 100% Power Testing and True Voltage Ratings for the ultimate in application reliability.

All these features plus new low prices permit you to start today to upgrade your existing germanium and silicon systems, and to be competitive on all new solid state power systems.

To receive your copy of the industry's most complete evaluation of power switching, write for "High Power Switching with the 30-ampere Silicon Power Transistor." Westinghouse Electric Corp., Semiconductor Department, Youngwood, Pa. *You can be sure... if it's Westinghouse.*

SC-1052

**Westinghouse**

**For Prompt Delivery, Order From These Westinghouse Distributors:**

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|---|---|
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| CAMERADIO | Pittsburgh, Pa./EX 1-4000 |
| CRAMER ELECTRONICS, INC. | Boston, Mass./CO 7-4700 |
| ELECTRONIC WHOLESALERS, INC. | Melbourne, Florida/PA 3-1441 |
| GENERAL RADIO SUPPLY CO., INC. | Camden, N. J./WO 4-8560 |
| GENESEE RADIO PARTS CO. | Buffalo, N. Y./TR 3-9661 |
| KANN-ELLERT ELECTRONICS, INC. | Baltimore, Md./TU 9-4242 |
| MILGRAY ELECTRONICS | New York, N. Y./RE 2-4400 |
| RADIO & ELECTRONIC PARTS CORP. | Cleveland, Ohio/UT 1-6060 |
| SCHWEBER ELECTRONICS | Long Island, N. Y./PI 6-6520 |
| | Silver Spring, Md./JU 5-7023 |

**MIDWESTERN**

| | |
|---|---|
| E.C.I. SEMICONDUCTORS, INC. | Kansas City, Mo./WE 1-0829 |
| ELECTRONIC COMPONENTS FOR INDUSTRY CO. | St. Louis, Mo./WO 2-9916 |
| HALLMARK INSTRUMENTS CORP. | Dallas, Texas/RI 7-8933 |
| INTER-STATE RADIO & SUPPLY CO. | Denver 4, Colo./TA 5-8257 |
| LENERT CO. | Houston, Texas/CA 4-2663 |
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| | Phoenix, Ariz./AL 8-8254 |
| | Albuquerque, N. M./CH 7-0236 |
| RADIO DISTRIB. CO. | Indianapolis, Ind./ME 7-5571 |
| SEMICONDUCTOR SPEC., INC. | Chicago, Ill./NA 2-8860 |
| S. STERLING CO. | Detroit, Mich./BR 3-2900 |
| UNITED RADIO, INC. | Cincinnati, Ohio/MA 1-6530 |

**WESTERN**

| | |
|---|---|
| ALMAC ELECTRONICS CORP. | Seattle, Wash./PA 3-7310 |
| ELMAR ELECTRONICS | Oakland, Cal./TE 4-3311 |
| HAMILTON ELECTRO SLS. | Los Angeles, Cal./BR 2-9154 |
| | Palo Alto, Cal./DA 1-7541 |
| NEWARK ELECTRONICS CO. | Inglewood, Cal./OR 4-8440 |

Circle 74 on Inquiry Card

# Letters to the Editor

## Teaching Machines

*Editor*, ELECTRONIC INDUSTRIES:

I was extremely satisfied, to find, in the October issue, that ELECTRONIC INDUSTRIES has realized the immediate importance of "Electronic Teaching." I have the following comments on points made in your editorial:

1. The "principle" of teaching machines and programmed learning is far from new, and it was not "begun" by Dr. B. F. Skinner "only a few years ago." Even with the assumption that a principle can be "begun" and not "discovered," we must give the proper credit. Dr. Sidney L. Pressey of The Ohio State University conceived the idea sometime before March 20, 1926, on which date appeared the first of three articles devoted to the concept. These articles (A Simple Apparatus Which Gives Tests and Scores—and Teaches; A Machine for Automatic Teaching of Drill Material; and A Third and Fourth Contribution Toward the Coming "Industrial Revolution" in Education) were published in *School and Society* during 1926, 1927, and 1932. Complete reprints of these articles, in addition to an exceptional overview of the field, may be found in *Teaching Machines and Programmed Learning, A Source Book* (NEA, Department of Audio-Visual Education, Washington, 1960), which may be obtained from The National Education Association, 1201 Sixteenth Street N.W., Washington, D. C. for $7.50.

2. As I implied above, there is no present "major breakthrough" in the need to improve our educational system. The breakthrough came several years ago. Actually, it is an irrefutable fact that major breakthroughs in hundreds of technological pursuits have placed such a demand on the educational system that teaching machines must be considered as a solution to the problem.

3. It has not been proven—as a matter of fact there is a great controversy about—whether a teaching machine can ever be expected to take the place of the human factor in education. Is it possible that a student will learn merely because he is learning? Or is the personal element, the verbal interaction, the human factor a great part of the reinforcement process? Great minds have not answered this question; let us in the electronics industry not force an answer by ignoring the psychology of education as we flood the market with great numbers of gadgets.

4. The electronics industry has recently enjoyed a great feast at the

(*Continued on page* 76)

*G.E.-Edmore provides you with this important advantage:*

# WIDEST SELECTION

## IN THE INDUSTRY

Thermistors and varistors for virtually any application . . . this wide selection is a big advantage when you use G.E.-Edmore as your source for specialty resistors. ■ G-E Varistors — voltage sensitive resistors — are made from Thyrite®, the unique, non-linear resistance material developed by G.E. They range from 0.1 to 250 watts, from 6 volts to 15 kilovolts DC for single units, and can be combined in series/parallel to meet wider requirements. These simple, rugged units offer many advantages over more costly devices for limiting voltage surges, for TV high voltage regulation, and as non-linear computer elements. ■ G-E Thermistors, both positive and negative temperature coefficients, are available in a wide range of disks, rods, washer assemblies and probes. Standard grades 1 through 4, and a broad spectrum of special materials provides resistances ranging from 1 to 1,000,000 ohms at 25°C. Use them for anything from meat probes to space probes, hearing aids to telemetry—anywhere a simple, rugged temperature sensor, compensator or controller is desired. ■ A most important fact: strict quality standards are maintained with modern, automatic machinery and controls at G.E.-Edmore. We'd like to send you our brochures on Thermistors and Thyrite® Varistors. Just write us. Remember, all catalog items can be delivered promptly—and our engineers will be glad to help you with special problems.

**MAGNETIC MATERIALS SECTION**

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**MAGNETIC MATERIALS • THERMISTORS**
**THYRITE® VARISTORS**

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**To Contractors and Subcontractors on U.S. Government Projects**

# NEW TRANSISTOR 2N1645

■ HIGH RELIABILITY ■ ONE WATT POWER OUTPUT AT 100 MC/S
■ EFFICIENCY APPROXIMATELY 50%

The 2N1645 is a diffused base germanium mesa transistor for UHF power amplifiers, frequency multipliers, and very high speed, high current switching applications. Typical turn-on and turn-off times under constant voltage drive conditions are less than 5 and 15 nanoseconds respectively. Power output of one-half watt as a doubler may be achieved up to 250 megacycles.

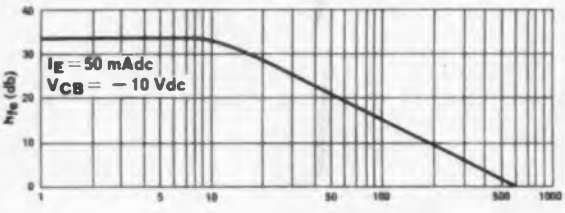
**MAXIMUM RATINGS AT 25°C**

| | |
|---|---|
| Collector Current | 300 mAdc |
| Collector Voltage | 35 Volts |
| Emitter Voltage | 1 Volt |
| Junction Temperature | 100°C |
| Power ($T_A = 25°C$) | 1 Watt |
| Power ($T_C = 25°C$) | 6 Watts |

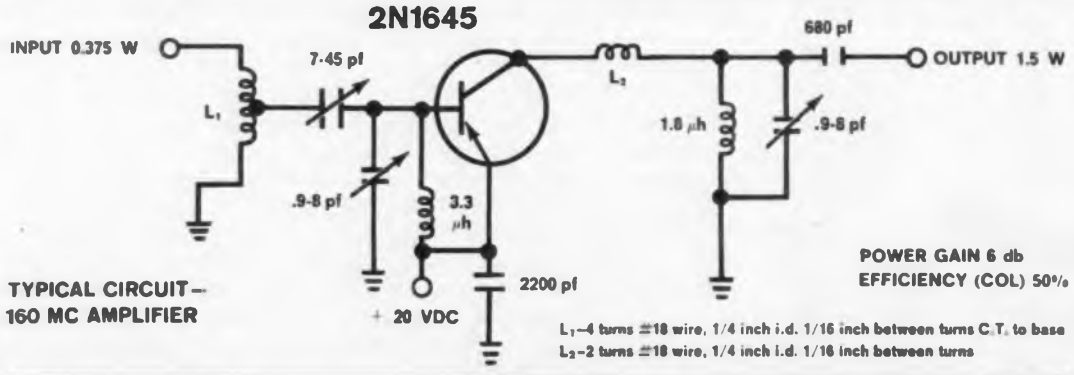
**TYPICAL ELECTRICAL CHARACTERISTICS**

| | |
|---|---|
| $f_t$ | 600 mc |
| $REh_{ie}$ (250 mc) | 23 ohms |
| $C_{cb}$ (dir) | 10 pf |
| $h_{fe}$ (1000 cps) | 50 |
| $h_{FE}$ ($I_C = 100$ mA) | 35 |

**TYPICAL CURRENT GAIN VS FREQUENCY**




FREQUENCY IN MEGACYCLES



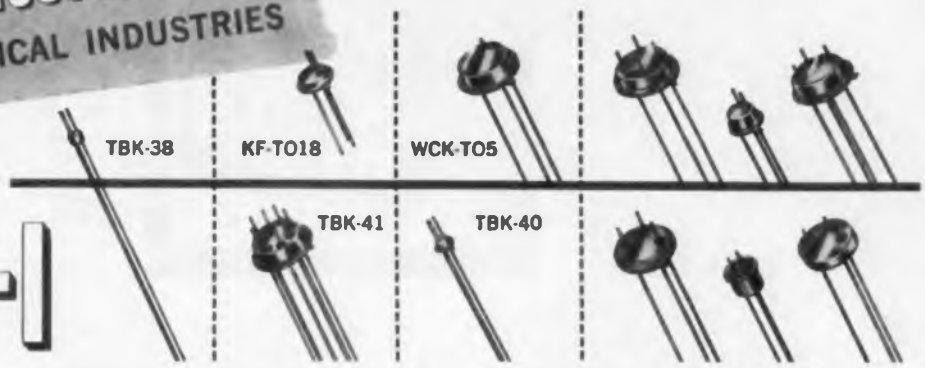

TYPICAL CIRCUIT—
160 MC AMPLIFIER

The 2N1645 transistor may be purchased in quantity from Western Electric's Laureldale Plant. For technical information, price, and delivery, please address your request to Sales Department, Room 105, Western Electric Company, Incorporated, Laureldale Plant, Laureldale, Pa. Telephone—Area Code 215—WAlker 9-9411.

**LAURELDALE PLANT**

Western Electric
MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

# Semiconductor News from ELECTRICAL INDUSTRIES




NEW E-I

# TRANSISTOR BASES

The new Electrical Industries line of hermetically sealed transistor bases includes types for Jedec Series TO5, TO9, TO18, TO33 and TO46 packages, miniatures for hearing aids and other applications, and bases for practically all military and commercial requirements. MIL types equal or exceed military specifications. Available in a broad selection of terminal configurations with finishes of Brite Gold, electro-tin or high purity gold for direct fusion of semiconductor elements to header base. Special plating on order.

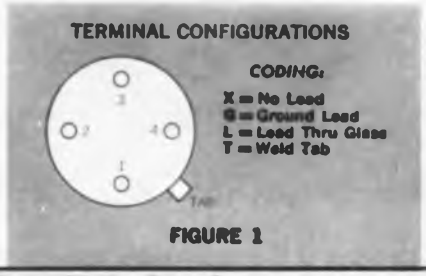



FIGURE 1

| | CODE NUMBER | TERMINALS (SEE FIGURE 1) | | | | LEAD LENGTH IN INCHES (See Figure 2) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | STANDARD TYPES | | MODIFICATIONS AVAILABLE | | | | | | |
| | | | | | | | | MOD. A | MOD. B | MOD. C | MOD. D | MOD. U | MOD. V | MOD. W | MOD. X |
| | | 1 | 2 | 3 | 4 | A DIMENSION | B DIMENSION | A DIM. | A DIM. | A DIM. | A DIM. | A DIM. | A DIM. | A DIM. | A DIM. |
| STRAIN FREE TYPES | K-TO5-XGLL | X | G | L | L | 13/64 | 1.500-1.532 | .020-.025 B DIMENSION = 1.500-1.532 | | .050-.060 | .095-.105 | .105-.110 | | | |
| | K-TO5-XLLL | X | L | L | L | | | | | | | | | | |
| | WCK-TO5-XGLL* | X | G | L | L | | | | | | | | | | |
| | K-TO5-TLLL | T | L | L | L | | | | | | | | | | |
| | K-TO18-XGLL | X | G | L | L | .110-.130 | .500-.520 | .017-.022 B DIMENSION = .500-.520 | | .025-.030 | .045-.055 | | .110-.130 B DIMENSION = 1.500-1.532 | .017-.022 | .025-.030 | .045-.055 |
| | K-TO18-XLLL | X | L | L | L | | | | | | | | | | |
| | KF-TO18-XGLL | X | G | L | L | .110-.130 | .500-.520 | .017-.022 B DIMENSION = .500-.520 | | .025-.030 | .045-.055 | | | | | |
| | K-TO33-GLLL | G | L | L | L | .090-.110 | 1.500-1.532 | .020-.025 B DIM. = 1.500-1.532 | | .050-.060 | | | | | | |
| | K-TO33-LLLL | L | L | L | L | | | | | | | | | | |
| | TBK-38 | 3 SPACED 120° | | | | 5/32 | 1-5/8 | | | | | | | | |
| | TBK-40 | 3 SPACED 120° | | | | 5/32 | 1-5/8 | | | | | | | | |
| | TBK-41 | 8 SPACED 45° | | | | 13/64 | 1.500-1.532 | | | | | | | | |
| COMPRESSION TYPES | WSF-TO5-XGLL | X | G | L | L | .090-.110 | 1.500-1.532 | .020-.025 B DIM. = 1.500-1.532 | | .050-.060 | | | | | |
| | WSF-TO5-XLLL | X | L | L | L | | | | | | | | | | |
| | WSF-TO5-GLLL | G | L | L | L | | | | | | | | | | |
| | WSF-TO5-TLLL | T | L | L | L | | | | | | | | | | |
| | WS-TO9-XLLL | X | L | L | L | .095-.105 | 1.500-1.532 | | | | | | | | |

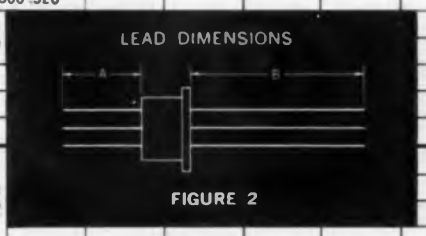



FIGURE 2

* COPPER CLAD

***ALSO AVAILABLE*** — Hermetically sealed clear glass caps for photo-sensitive devices utilizing TO5 and TO18 type bases.


## ELECTRICAL INDUSTRIES

MURRAY HILL, NEW JERSEY, U. S. A.

*A Division of Philips Electronics & Pharmaceutical Industries Corp.*

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# Letters to the Editor

(*Continued from page* 72)

expense of the taxpayers' dollars ostensibly spent for defense. We must all admit that we have let a few bad apples slip into the barrel at the expense of efficient use of defense monies. Educators understand electronics no better than those in the electronics industry understand education. Let us find out from educators what is necessary; then we may build our gadgets. At that point, let us test our gadgets to see if they are as useful as our bank accounts would like them to be. If they are, then a big mouthful of the "more than $30 billion" is ours to chew on for a long time. However, if these gadgets do not do the job, and we force them down the throats of educators, two things are inevitable: we will be out of the field before we can say "Skinner did not discover the teaching machine principle," and education in the United States will require several years recovering from our blunders. We will suffer from both!

Curtner B. Akin, Jr.
Post Office Box 154
Gracie Station
New York 28, N. Y.

## "Optimum Burn-In—"

*Editor,* ELECTRONIC INDUSTRIES:

Will you please clarify the Tables from the article, "Determining Optimum Burn-in for Capacitors," in the September 1961 issue of ELECTRONIC INDUSTRIES?

What do the following signify: SS, DF, MS, F and F.05?

Lois Bunce
The Bendix Corporation
Seintilla Div.,
Sidney, N. Y.

*Editor,* ELECTRONIC INDUSTRIES:

The first five tables in the article show the standard form of presentation for analysis of variance. Accordingly, the abbreviations are as follows:

SS—Sum of Squares
DF—Degrees of Freedom
MS—Mean Square
F—Variance Ratio
F.05—Value of variance ratio from F tables at the 5% level

It should be noted that in Table 1 an error exists. Interaction BC should have 3 degrees of freedom and Interaction ABC (the residual) should have 12 degrees of freedom. These errors cause changes for the Mean Square value for those items, but the changes do not affect the conclusions drawn from the table.

Lawrence D. Hines
Corning Glass Works
Bradford, Pa.

(*Continued on page* 82)

## want to argue about fusion vs compression seals?

# Fusite has the best of both!

We take no sides in the continuing debate over the relative merits of fusion and compression seals. We are prepared to discuss the advantages of both and let each customer decide for himself which best suits his need.

The superiority of Fusite Terminals over all others starts with our own glass smelting facilities. Stock commercial glasses simply cannot compare to the highly specialized glasses we have developed for use with 446 stainless, mild steel or 52% nickel alloy pins.

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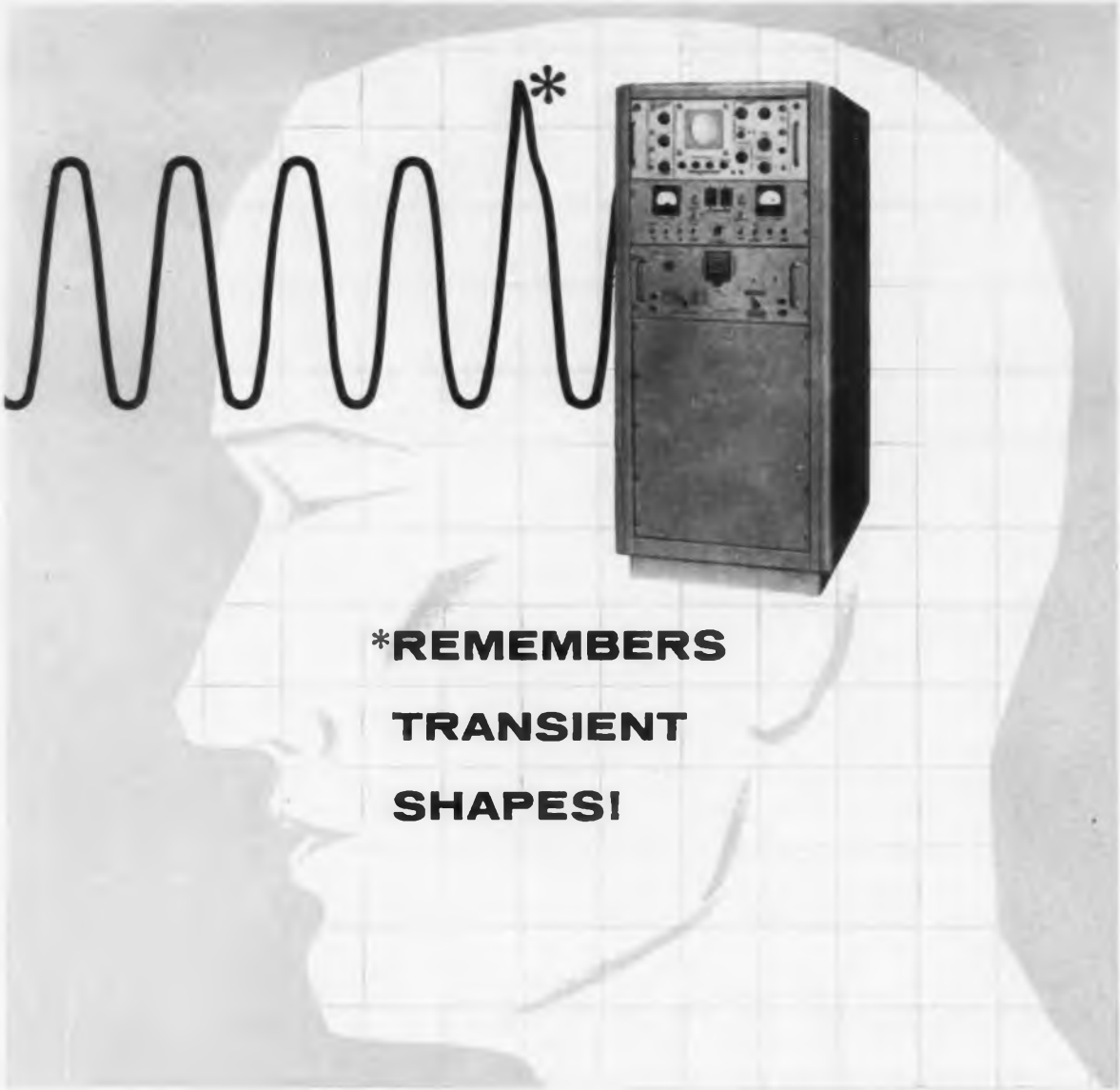


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Data on a single transient waveform is "remembered" by a barrier grid storage tube, and readout can be conducted as long as 72 hours after recording. As easy to operate as a regular Oscilloscope, the unit is equipped for display and optional printout of analysis. Rise time, 0.25 microsecond minimum with linearity over a useful tube storage area. Voltage input, 600V maximum combined DC and peak AC with input characteristics of 1 megohm, 36 uuf direct; 10 megohm, 12 uuf with 10x probe.

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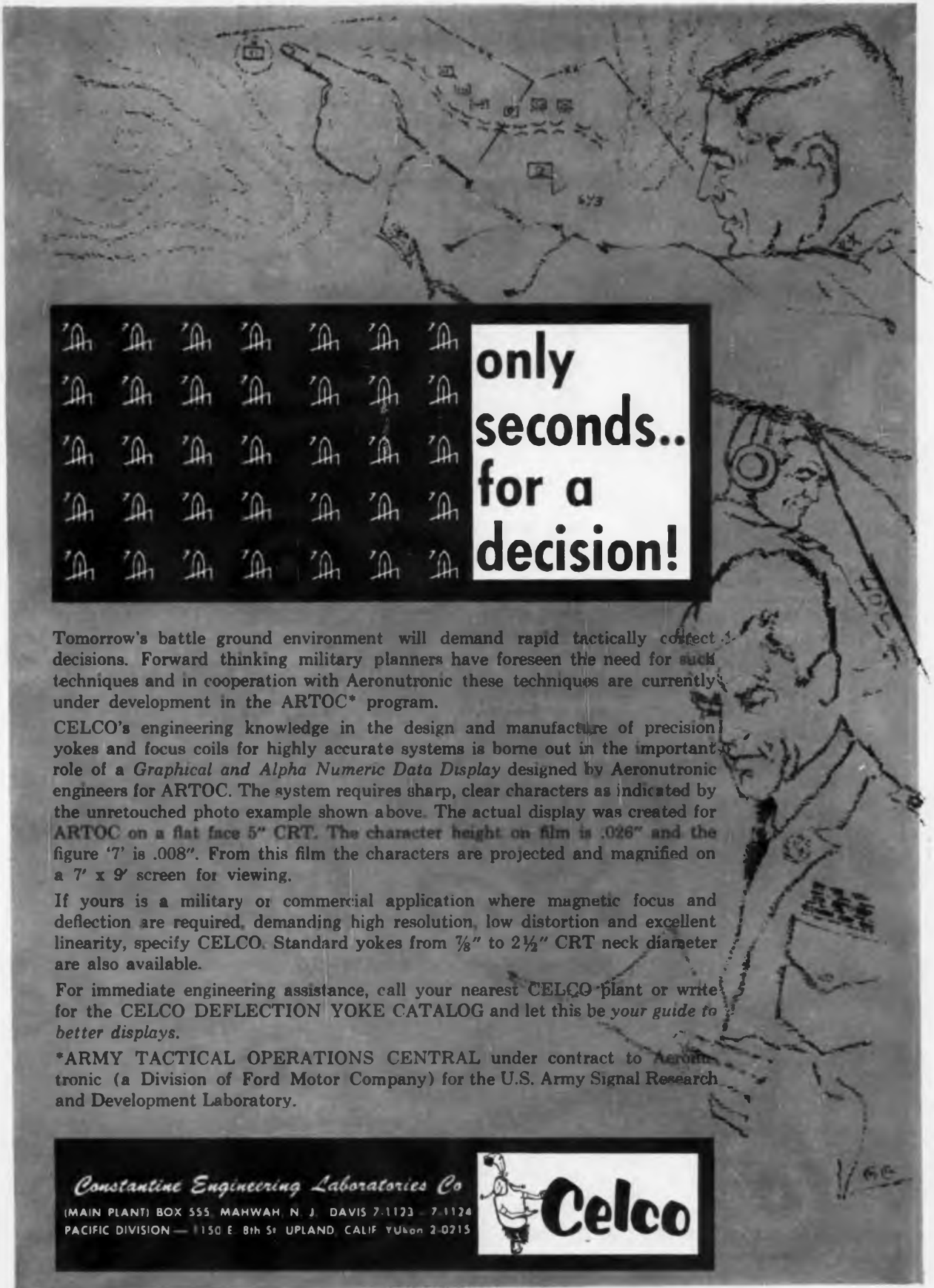

# only seconds.. for a decision!

Tomorrow's battle ground environment will demand rapid tactically correct decisions. Forward thinking military planners have foreseen the need for such techniques and in cooperation with Aeronutronic these techniques are currently under development in the ARTOC* program.

CELCO's engineering knowledge in the design and manufacture of precision yokes and focus coils for highly accurate systems is borne out in the important role of a *Graphical and Alpha Numeric Data Display* designed by Aeronutronic engineers for ARTOC. The system requires sharp, clear characters as indicated by the unretouched photo example shown above. The actual display was created for ARTOC on a flat face 5" CRT. The character height on film is .026" and the figure '7' is .008". From this film the characters are projected and magnified on a 7' x 9' screen for viewing.

If yours is a military or commercial application where magnetic focus and deflection are required, demanding high resolution, low distortion and excellent linearity, specify CELCO. Standard yokes from ⅞" to 2½" CRT neck diameter are also available.

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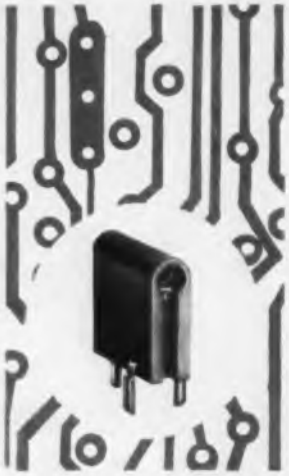
Celco

Circle 82 on Inquiry Card



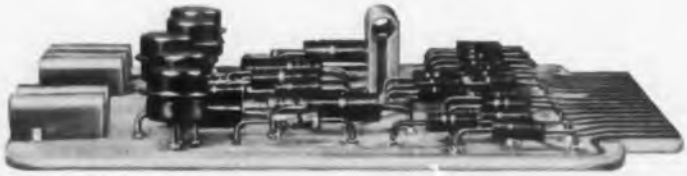
The taller three-leg mount permits testing above components, anywhere on the board.

The standard-height three-leg mount achieves maximum stability for board-end testing.

The two-leg mount receptacle yields maximum density for test probes at the board ends.

# BEST FOR ANY TEST

These three test probe receptacles will permit you to test probe any printed circuitry anywhere on the board . . . on the ends or in the middle . . . without interrupting operating currents.



Each of the receptacles is available in 10 nylon housing colors and natural. The receptacle inserts, in either gold or silver plate, are recessed in the housings to prevent flashover, and are double-ended for either-end probes. Leg mounts are "V" shaped, to promote controlled solder wicking. Each of the receptacles accepts the standard .080 test probe.

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# All that's new in PLASMA research

read

December

## Proceedings

for the facts!

No matter what your field in electronics, having a working knowledge of plasmas is greatly to your advantage. Why? Because plasmas are becoming increasingly important in electronics research and application.

Think of the major new developments in this field. Scientists are using gaseous plasmas to convert heat directly into electricity. Will this affect your work? Of course it will! Others are designing new vacuum pumps, again with gaseous plasmas helping to increase efficiency. Do you see the impact this will have on vacuum tubes, on a whole host of electronics products?

Much specialized research has been done on gaseous plasmas in the last few years. Much more is being planned. To catch up with it, you'd have to read a mass of technical papers, weed through conflicting theories, and often find at the end that the research is not pertinent to your work at all.

Realising this . . .

*Proceedings of the IRE* devotes its entire December issue to a survey of plasma research and findings to date . . . More than 15 technical papers, each one written by an authority, will spell out what plasmas are, how they behave, what they can do. Guest editor is Dr. E. W. Herold, Vice President, Research, Varian Associates.

Every special issue of *Proceedings* in the past has remained a definitive reference work for years. Many were sold out almost immediately. If you are not a member of the IRE, make sure of your copy of the December special issue on plasmas by sending in the coupon immediately.

***more than 15 definitive papers covering the following areas of plasma research and application:***

1. Fundamental plasma processes
2. Applications to communications
3. Electric power generation
4. Propulsion systems
5. Low density plasma explorations
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7. Diagnostic procedures

**Proceedings of the IRE**

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Please send me the December 1961 issue of **Proceedings of the IRE**, containing a survey of the research carried out on plasmas.

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*Extra copies to IRE members, $1.25 each (limit: 1 extra to a member).

NAME_____

COMPANY_____

ADDRESS_____

# Letters to the Editor

(*Continued from page 76*)

## Coming Events

*Editor*, ELECTRONIC INDUSTRIES:

I have found your "Coming Events" section very interesting and useful. I suggest that to make it even more so, you give more advanced notice such as list the September or October meetings in the August issue rather than list the August meetings. Earlier notice on some of the "Call for Papers" would also be helpful as some are not listed until at, or past, the deadline for abstracts.

The ELECTRONIC INDUSTRIES listing lets many engineers know about meetings they would not otherwise find, but often too late to attend or contribute a paper.

I am writing this knowing that you may be unable to get the information earlier but taking the chance that you had not thought of this way to improve an already good section.

L. E. Fay III
Senior Engineer—Magnetics

Bryant Computer Products
850 Ladd Road
Walled Lake, Mich.

---

Edit: We are making an effort to make some modifications in this feature. We do not have too much difficulty in getting the information in sufficient time; our problem is rather one of available space for this department, and a more judicious selection of dates has to be made.

Hereafter, in the month of issue we will not list any dates that are occurring before the 10th of that month, and will seek to take advantage of the space gained thereby to bring up the more important events to come in succeeding months.

Editor

---

## What Price RELIABILITY?

*Editor*, ELECTRONIC INDUSTRIES:

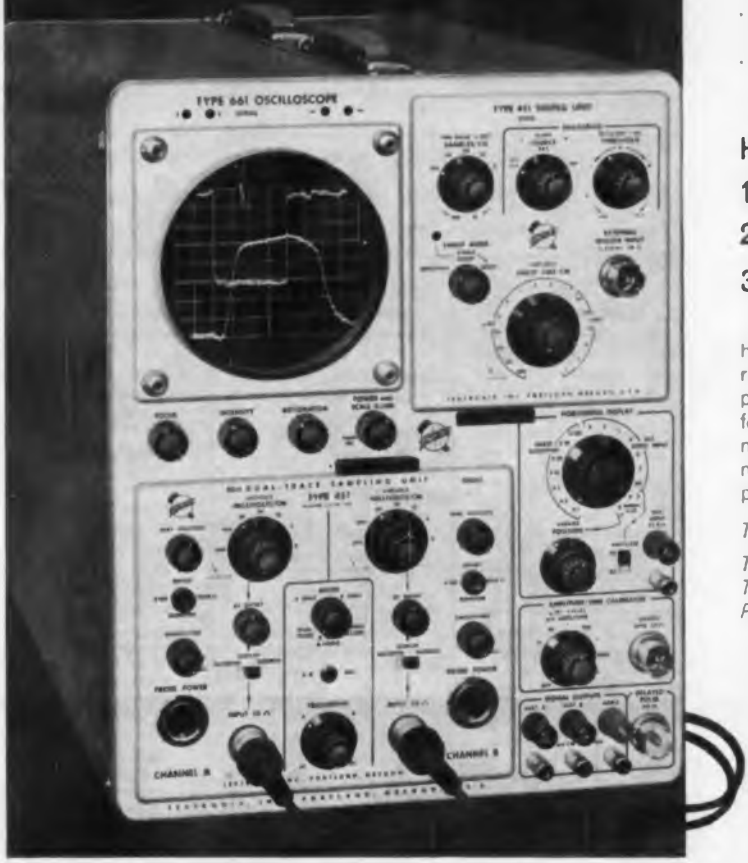
I have read the article "What Price Reliability?" by John Hickey in the September issue of ELECTRONIC INDUSTRIES, and think it is an outstanding article on the subject of military equipment and system reliability.

I would like to have 12 reprints . . .

F. L. Ankenbrandt
Maj. General, USAF (Ret.)
Manager, Defense Product Assurance
Radio Corporation of America
Defense Electronic Products
Camden 2, N. J.

# SIMPLIFY
## YOUR PULSE-SAMPLING MEASUREMENTS

*with this NEW Tektronix Dual-Trace Oscilloscope*




**Type 661**

### Here's what you can do:

. . . trigger externally, or *internally* on either A or B trace,
. . . observe equivalent sweep times from 3.3 picoseconds to a millisecond,
. . . display repetitive signals from fractions of millivolts to volts—with wider range possible using external attenuators,
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1 Plug in the power cord and signal source,
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In one compact laboratory oscilloscope you have a complete pulse sampling system with risetime of 0.35 nanosecond. Using the 50Ω inputs, or the Tektronix passive probe or cathode-follower probe designed for use with the instrument, you can meet most of the general-purpose-measurement demands in repetitive-signal applications.

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| *Type 661* Oscilloscope (without plug-ins) | $1150 |
| *Type 4S1* 50Ω Dual-Trace Sampling Unit | $1430 |
| *Type 4T1* Timing Unit . . . . . | $ 750 |
| *Probes:* | |
| Type P6026 Passive Probe. . . . . | $ 140 |
| Type P6032 Cathode-Follower Probe. . | $ 160 |

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**For complete information on the characteristics and capabilities of this new Pulse-Sampling Oscilloscope, please call your Tektronix Field Engineer.**

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MODEL 825A

MODEL 801B

MODEL 8011A

## DC DC DC

## . . . Accuracy 0.025%

# ALL 3 NEW

| MODEL NO. | INPUT VOLTAGE RANGE | ACCURACY | MAXIMUM FULL SCALE SENSITIVITY | MAXIMUM METER RESOLUTION | REFERENCE |
|---|---|---|---|---|---|
| 825A | 0-500V | ±0.025% | 1 mv | 5 uv | STD. CELL } ZENER DIODE OPTIONAL |
| 801B | 0-500V | ±0.05% | 10 mv | 50 uv | STD. CELL } ZENER DIODE OPTIONAL |
| 8011A | 0-500V | ±0.05% | 10 mv | 50 uv | TEMP. CONTROLLED ZENER DIODE |

### 825A

The 825A provides ±0.025% accuracy over the entire 0-500 volt range.

**DIMENSIONS:**
Cabinet Model—
9¾" wide x 13" high x 14" deep.
Rack Model—
19" wide x 7" high x 14" deep.

**WEIGHT:**
Cabinet Model—
25 pounds.
Rack Model—22 pounds.

**PRICE:**
Cabinet Model—$555.00
Rack Model—$575.00

### 801B

Lower priced—0.05% accuracy of input voltage 0.1 to 500 v.

**DIMENSIONS:**
Cabinet Model—
9¾" wide x 13" high x 14" deep
Rack Model—
19" wide x 7" high x 14" deep

**WEIGHT:**
Cabinet Model—
24 pounds.
Rack Model—
21½ pounds.

**PRICE:**
Cabinet Model—$485.00
Rack Model—$505.00

### 8011A

Meets all environmental requirements of MIL-T-945B.

**DIMENSIONS:**
In combination case with cover in place—
19" wide x 11½" high x 19½" long

**WEIGHT:**
57 pounds

**FINISH:**
Light grey enamel per MIL-E-150908, Class III, Type 2

**PRICE:**
$1,745.00

**High accuracy measurements to 30,000 V DC with NEW Fluke**

### PRECISION VOLTAGE DIVIDERS

Designed for use with the Fluke Model 800 Series Differential Voltmeters, all units have zero center panel meters to indicate polarity and approximate magnitude of unknown high voltage. All models draw 1 ma current at maximum input.

| MODEL NO. | MAXIMUM INPUT VOLTAGE | TOTAL RESISTANCE | DIVISION RATIO 500 V OUT | DIVISION RATIO IV OUT | DIVISION RATIO ACCURACY | PRICE |
|---|---|---|---|---|---|---|
| 80A-1 | 1 KV | 1 M | 2:1 | — | ±0.015% | $ 100.00 |
| 80A-2 | 2 KV | 2 M | 4:1 | — | ±0.015% | 110.00 |
| 80A-5 | 5 KV | 5 M | 10:1 | 5,000:1 | ±0.01% | 225.00 |
| 80A-10 | 10 KV | 10 M | 20:1 | 10,000:1 | ±0.01% | 350.00 |
| 80A-15 | 15 KV | 15 M | 30:1 | 15,000:1 | ±0.01% | 720.00 |
| 80A-20 | 20 KV | 20 M | 40:1 | 20,000:1 | ±0.01% | 845.00 |
| 80A-25 | 25 KV | 25 M | 50:1 | 25,000:1 | ±0.01% | 970.00 |
| 80A-30 | 30 KV | 30 M | 60:1 | 30,000:1 | ±0.01% | 1,095.00 |

# VOLTAGE MEASUREMENTS

## Measure to any degree of accuracy required . . .

1%, 0.2%, and 0.02% accuracies are now available to the electronics engineer as a result of Fluke research and development. The degree of accuracy desired is dependant on the particular application and the engineer need no longer be limited by the measuring equipment available to him.

FLUKE

Model 910A True RMS Voltmeter is a new basic instrument which combines true RMS response with 1.0% accuracy over a broad frequency range. Its true RMS response, by definition, guarantees that the accuracy of the indicated reading, of any periodic waveform, is maintained regardless of its amplitude characteristics.

Model 803 Differential Voltmeter, employing the differential measurement technique, provides versatility in measuring either AC or DC to high orders of accuracy.

Model 540A Thermal Transfer Standard, provides extreme accuracy for applications requiring measurement capability equal to the limits of accuracy certified by the National Bureau of Standards.

**AC** **NEW**

### MODEL 910A
**TRUE RMS VOLTMETER**

| | |
|---|---|
| **Voltage Range:** | 1.0 mv to 300 v full scale in twelve ranges. |
| **Decibel Range:** | −72 to +52 dbm in 12 ranges. |
| **Frequency Response** | 10 cps to 7MC |
| **Accuracy:** | ±1% of full scale 50 cps to 800 KC<br>±2% of full scale 20 cps to 2 MC<br>±3% of full scale 20 cps to 3.5 MC<br>±5% of full scale 10 cps to 7.0 MC |
| **Crest Factor:** | Three at full scale. Proportionately high for readings of less than full scale. |
| **Input Impedance:** | 10 megohms shunted by 30 uuf on ranges from 0.001 v to 0.300 v.<br>10 megohms shunted by 15 uuf on ranges from 1.0 v to 300 v. |
| **Amplifier:** | Output terminals provide approximately 100 mv RMS at full scale, regardless of range. |
| **Dimensions:** | Cabinet Model—7¼" wide x 10½" high x 15" deep.<br>Rack Model—19" wide x 5¼" high x 13¼" deep. |
| **Price:** | Cabinet Model—$545.00<br>Rack Model—$565.00 |

**AC/DC**

### MODEL 803
**PRECISION AC/DC DIFFERENTIAL VOLTMETER**

| | |
|---|---|
| **Voltage Range:** | DC—0-500 volts<br>AC—0.03-500 volts |
| **Accuracy:** | DC—±0.05% of input voltage from 0.1-500 v.<br>±0.1% of input voltage or 50 uv, whichever is greater from 0 to 0.1 v.<br>AC—±0.2% of input voltage from 0.5-500 v. over 30 cps to 10 KC frequency range. Reduced accuracy from 0.03-0.5 v. |
| **Input Impedance:** | DC—Infinite at null. AC—1 megohm shunted by 25 uufd. |
| **Reference:** | Standard cell, zener reference optional at additional cost. |
| **Dimensions:** | Cabinet Model—9¾" wide x 13" high x 16" deep.<br>Rack Model—19" wide x 8¾" high x 17 5/16" deep. |
| **Weight:** | Cabinet Model—30 pounds<br>Rack Model—38 pounds |
| **Price:** | Cabinet Model—$875.00<br>Rack Model—$895.00 |

**AC/DC** **NEW**

### MODEL 540A
**AC/DC THERMAL TRANSFER STANDARD**

| | |
|---|---|
| **Voltage Ranges:** | 0.5, 1, 2, 3, 5, 10, 20, 30, 50, 100, 200, 300, 500, 1000 volts. |
| **Absolute Accuracy:** | To 75v: ±0.02% to 50 KC<br>±0.03% to 500 KC<br>To 750v: ±0.025% to 50 KC<br>To 1000v: ±0.02% to 20 KC |
| **Calibration:** | Traceable to NBS certification to 50 KC. |
| **Transfer Input Impedance:** | 200 ohms/volt |
| **Galvanometer Resolution:** | 0.02%/millimeter, provision for external galvanometer provided. |
| **Dimensions:** | 10¾" wide x 8½" high x 14½" long. |
| **Weight:** | 11½ pounds. |
| **Price:** | $795.00 |

*All prices FOB Factory, Seattle.*
**Prices and data subject to change without notice.**

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**Fluke has shipped over 12,000 precision voltmeters for use on the line and in the lab. This impressive figure alone, attests to the wide acceptance these instruments have enjoyed.**

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# Books

### *Programming Computers for Business Applications*

*By Ned Chapin. Published 1961 by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. 279 pages. Price $7.50.*

A practical guide that explains the how and why of programming, provides modern techniques for accuracy in data processing, and supplies programming principles and methods applicable to all computers. Fundamental procedures common to all programming are discussed in detail, and full coverage is given such pertinent areas as sorting, re-runs, buffer use, timing, random access, and interrupt programming. Among topics covered are the preparation necessary for programming, simple and intermediate programming, programming to save storage, programming for accuracy and speed, and subroutines and library programs. COBOL —the Common Business Oriented Language—is stressed throughout.

### *Frequency Modulation Theory*

*By Jacques Fagot & Philippe Magne. Published 1961 by Pergamon Press Ltd., Headington Hill Hall, Oxford, England. 488 pages. Price $15.00.*

The book is divided into five main sections, the first part describing the conditions of metre, decimetre and centimetre wave propagation used in this region. The second part discusses all the fundamental concepts of frequency modulated systems, ending with a thorough examination of the signal-to-noise ratio. Problems of distortion in connection with propagation phenomena (double trajectory, mismatched feeders) are examined in the third part and a synthesis of all the proceeding concepts is given in the fourth which presents a complete study of the transmission by radio beams of multiplex telephonic for television programme signals. In the fifth part the problems of apparatus in the widest sense of the word are dealt with.

### *Systems: Research and Design, Proceedings of The First Systems Symposium at Case Institute of Technology*

*Edited by Donald P. Eckman. Published 1961 by John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y. 310 pages. Price $8.50.*

For the most part, the discussions pertain to analysis and synthesis in very large complex systems such as industrial manufacturing complexes, military systems, economic systems, and systems involving both men and machines. The basic topics touched upon in these problems are systems theory, communication, control, performance criteria, optimization, reliability, and human functions in the systems.

(*Continued on page* 90)

# BENDIX DIGITAL MODULE TESTER

**REDUCE TEST TIME TO SECONDS**

This portable, suitcase-type unit tests transistorized digital modules on a go, no-go basis in approximately 20 seconds. Larger, more complex printed circuit boards can be checked in approximately 45 seconds. It also reduces set-up time from hours to minutes over other methods. Net results: lower production costs; minimum downtime of the main computer; accelerated production rates; and positive test results.

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**SILICONE NEWS from Dow Corning**

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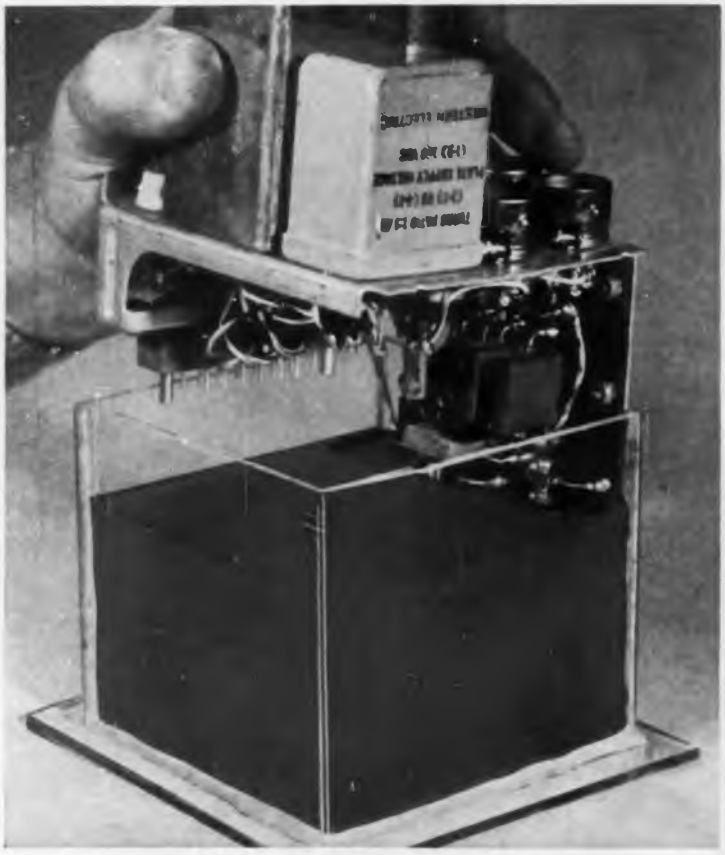

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For thick section embedding, specify Silastic RTV 601, a new fluid silicone rubber that vulcanizes at room temperature, cures thoroughly and completely . . . even in deep sections.

Like all potting and embedding materials in the Silastic RTV family, this one has excellent electrical and physical properties — resists moisture, voltage stress, corona, thermal cycling, temperature extremes, aging, weathering, ozone, many corrosive chemicals and their fumes.

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## Solder melts — laminate unaffected

Specified for their excellent resistance to space age environments, silicone-glass laminates are easy to work with, too. Soldering heat doesn't loosen terminals even where complex wiring requires repeated soldering in a small, confined area. Made with Dow Corning silicone resins, glass laminates retain their excellent dielectric properties despite heat, moisture, storage, environmental aging, rapidly changing ambients and vibratory shock. Light in weight, strong at elevated temperatures, they resist ozone, arcing, corona and fungus attack. In addition, they are easy to fabricate and assemble, have good physical properties . . . resist creep under pressure.

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## Silicone compound for heat sink seal

Heat sinks built by Fairfield Controls, Inc., Stamford, Conn., combine pure copper fins with Dow Corning 3 Compound to assure full load operation of silicon control rectifiers within the maximum allowable junction temperature of 125 C. Dow Corning compound with its petroleum jelly-like consistency, provides excellent heat transfer between the 25.5 amps diode shown here and the metallic parts of the heat sink assembly. The operating portion of the rectifier is inside the heat sink, with silicone compound to facilitate heat transfer from the entire diode body to the heat sink proper. At the same time, moisture and contaminates are sealed from the diode lead connections.

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## Key to stability — silicone fluid

Dow Corning silicone fluid is used in a new line of hermetically sealed precision film resistors developed by Key Resistor Corporation of Gardena, California, to "provide the ultimate in long term life and stability." According to Key engineers, "the unique silicone fluid filled construction results in excellent heat dissipation characteristics — minimizes effects of severe overloads." Dow Corning silicone fluids are used as filling and cooling media in numerous electronic and electro-mechanical applications because they maintain initial viscosity over a wide temperature range, are stable at high temperature, are excellent dielectrics . . . offer numerous other advantages.

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Free 12-page manual, "Silicones for the Electronic Engineer".
Write Dept. 4124, Dow Corning Corporation, Midland, Michigan.

# Books

(*Continued from page 86*)

### *Industrial Instrumentation*

*By Forrest C. Tyson, Jr. Published 1961 by Prentice-Hall, Inc., Englewood Cliffs, N. J. 365 pages. Price $9.00.*

The author treats the essential mechanisms of measurement, control, and remote control, or telemetering, at a level designed to give the technician all the background and information prerequisite to handling the instruments commonly used in industry today.

Major topics which the author presents include: pressure, recorders, flow, liquid level, temperature, humidity, control, control valves, transmitters, blind controllers, miniature recorders, and graphic panels. Each chapter concludes with a summary plus a problem and answer section for self-testing.

## Books Received

### *Using the Oscilloscope in Industrial Electronics*

*By Robert G. Middleton & L. Donald Payne. Published 1961 by Howard W. Sams & Co., Inc., 2201 East 46th St., Indianapolis 6, Ind. 256 pages. Paperbound. Price $4.95.*

### *Tube Substitution Handbook, Vol. 3, Revised*

*By Howard W. Sams engineering staff. Published 1961 by Howard W. Sams & Co., Inc., 2201 East 46th St., Indianapolis 6, Ind. 96 pages. Paperbound. Price $1.50.*

### *Industrial Transistor and Semiconductor Handbook*

*By Robert B. Tomer. Published 1961 by Howard W. Sams & Co., Inc., 2201 East 46th St., Indianapolis 6, Ind. 256 pages. Paperbound. Price $4.95.*

### *A Guide to FORTRAN Programming*

*By Daniel D. McCracken. Published 1961 by John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y. 88 pages. Price $2.95.*

### *Handbook of Electronic Charts and Nomographs*

*By Allan Lytel. Published 1961 by Howard W. Sams & Co., Inc., 2201 East 46th St., Indianapolis 6, Ind. 256 pages. Paperbound. Price $4.95.*

### *Spectrum Analyzer Techniques Handbook, 3rd Edition*

*Published 1961 by Polarad Electronics Corp., 43-20 34th St., Long Island City 1, N. Y. 34 pages. Paperbound. Price $0.50.*

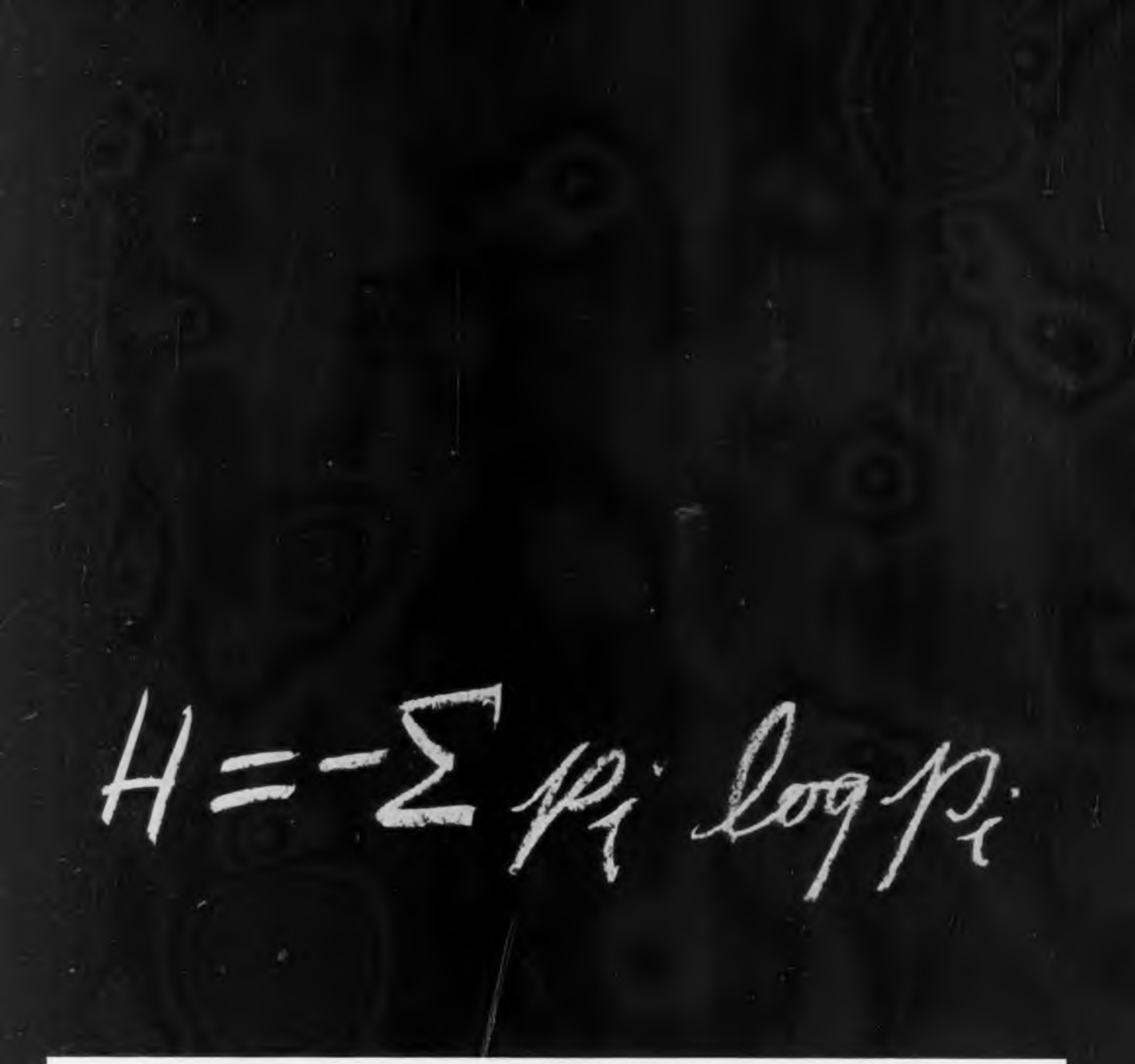
### *101 Key Troubleshooting Waveforms for Sync Circuits*

*By R. G. Middleton. Published 1961 by Howard W. Sams & Co., Inc., 2201 East 46th St., Indianapolis 6, Ind. 128 pages. Paperbound. Price $2.00.*

### *How to Fix Transistor Radios & Printed Circuits, 2 Volumes*

*By Leonard Lane. Published 1961 by Gernsback Library, Inc., 154 West 14th St., New York 11, N.Y. 320 pages. Price $5.90 for set of soft covers and $9.90 for set of hard covers.*

(*Continued on page 96*)




A basic formula from Information Theory . . . provides a measure of the amount of information in a particular type of message, such as TV . . . helps determine the frequency bandwidth, for example, required to transmit the messages. Information Theory, pioneered at Bell Laboratories, guides the search for better communications systems.

# DISCOVERY

## AT BELL TELEPHONE LABORATORIES

New knowledge comes in many forms. Sometimes it comes in a mathematical formula. Usually it comes after much thought and experiment and the fruitful interaction of different minds and abilities. Most often, too, a particular discovery is small. But many small discoveries have a way of leading to big advances at Bell Laboratories—advances like the transistor . . . or, more recently, the gaseous optical maser, forerunner of communications at optical frequencies. Opportunities for discovery are enhanced by the abilities of the scientists and engineers and the range of the facilities at Bell Laboratories, *world center of communications research and development.*

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Engineers at the Machlett Laboratories were faced with a perplexing problem — how to measure the speed of their new 10,000-rpm, rotating anode Dynamax "50A" X-Ray tube while immersed in oil. For many years, stroboscopic equipment had been used to measure anode speeds of approximately 3600 rpm, but older stroboscopes did not produce sufficient light intensity at the higher operating speeds of newer X-Ray tubes.

The recently announced Type 1531-A Strobotac solved Machlett's problem. This new design with its intense *white-light* and concentrated "long-throw" beam easily pierces the plastic cover shield, the oil, and the tube's glass envelope at rates as high as 25,000 flashes per minute. Measurements are made without need of auxiliary equipment or direct electrical or mechanical connection to the object under test.

## Type 1531-A STROBOTAC®

## Electronic Tachometer and Motion Analyzer

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. . . an important aid in the development and test of motors, synchros, loudspeakers, relays, vibrators, acoustical equipment, and countless other electrical and electro-mechanical devices.

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Bright White Light: 0.21, 1.2, and 4.2 million beam-candlepower (minimum) on high-, medium- and low-speed ranges, respectively. Long-throw beam reaches deep into machinery innards, enables measurements under normal room lighting.

Easy to Use: simplified range switch . . . pivoting lamp . . . carrying case provides protection and doubles as an adjustable bench stand . . . light weight and compact, only 7½ pounds . . . can be triggered with an external mechanical contractor or 6-volt peak-to-peak signal . . . can be operated from a 105-125 or 210-250 volt line, 50-60 and 400 cycles.

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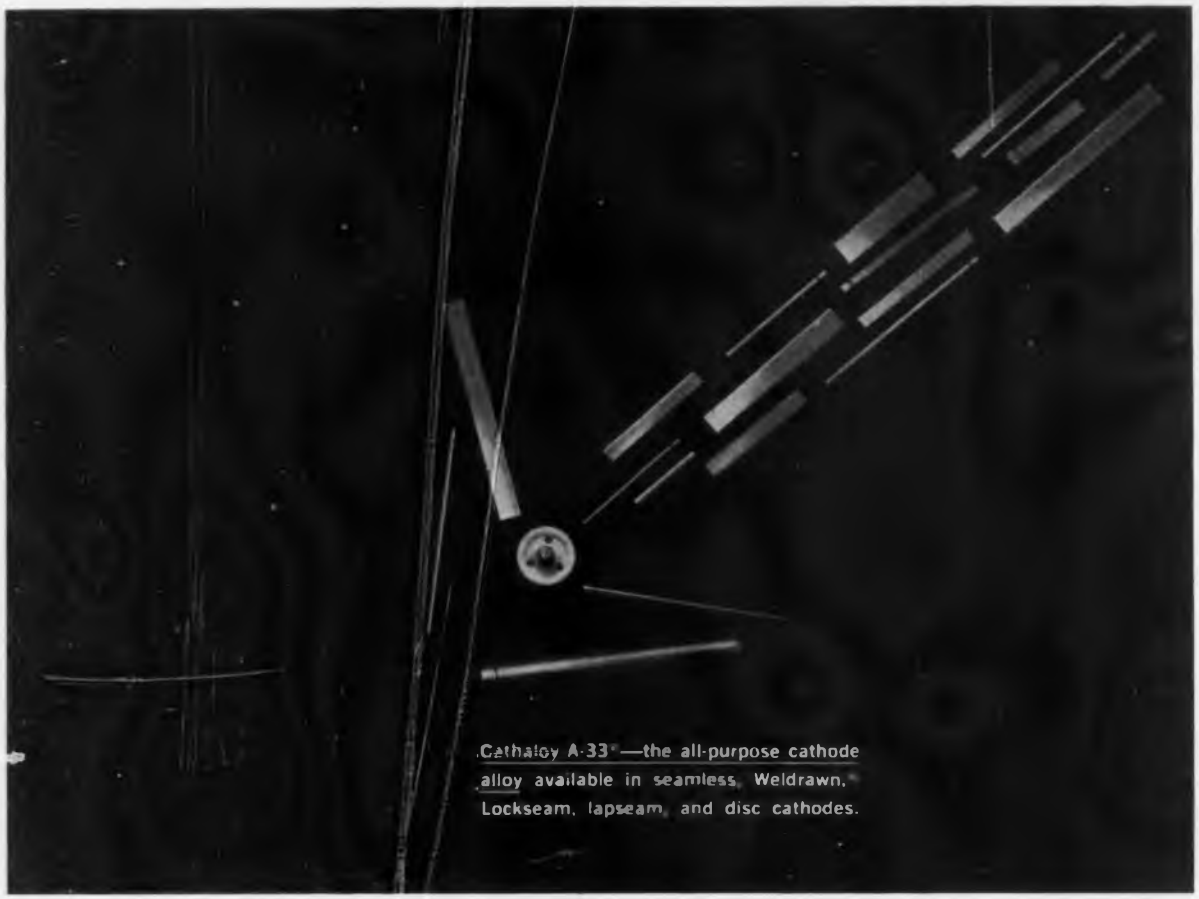


# NEW, SUPERIOR CATHALOY NAMED A-33 —PROVED IN USE FOR 2½ YEARS

Cathaloy A-33 was designed by Superior Tube to be free of the problems of interface impedance and sublimation associated with active cathode alloys and yet easier to activate than the passive cathode alloys. Laboratory tests of this tungsten-zirconium-nickel alloy proved the composition did all that was expected of it. But more evidence was wanted. So the cathode alloy was labeled experimental —X-3012. That was back in April, 1959. Since then tubemakers have tried it, confirmed the laboratory findings, and started using it in production.

Now this alloy is named Cathaloy® A-33 and is a member of Superior's family of individually controlled cathode alloys. Every heat of each Cathaloy material is tested by Superior for electron tube performance before being fabricated into cathodes for customers. Tests include activation rate, emission level, life and sublimation.

Get the complete facts on Cathaloy A-33. Write Superior Tube Co., 2502 Germantown Ave., Norristown, Pa.

*U.S. Patent No. 2,833,647 (Superior Tube Company)

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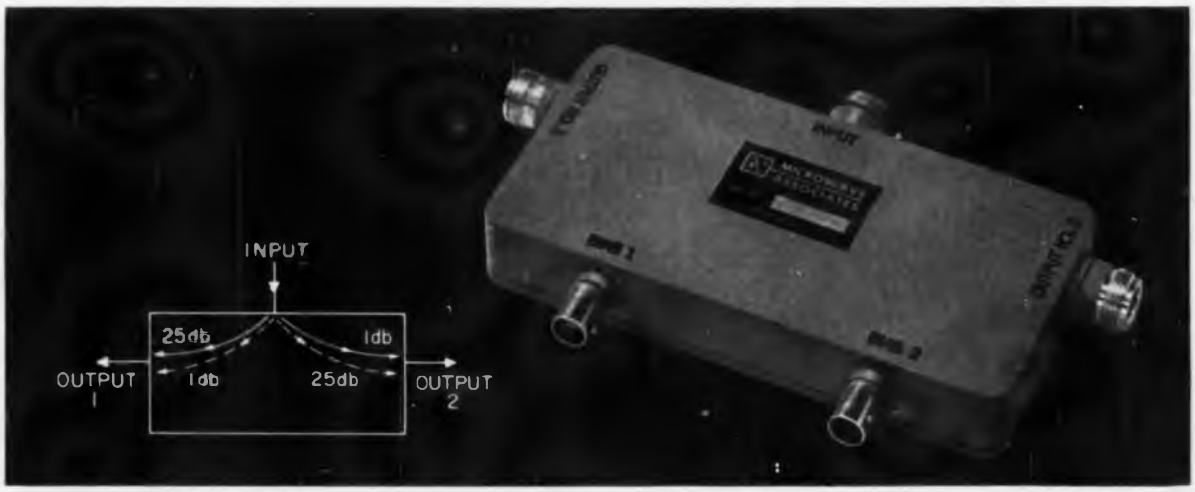


Microwave Associates has expanded its line of all-solid-state microwave devices with this new family of high power switches.

For applications at frequencies through 7 kMc, these coaxial transmission line units provide ruggedness, lightweight (units typically less than 16 oz.), and long-lived reliability which is not possible with other switching methods. The low drive power of these new units is unmatched. They provide 25 db isolation with 1 db insertion loss at 10 kw peak power, .002 duty cycle, and with typical bandwidths of 10%. Switches with higher power handling capability are currently under development.

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* Since there is no magnetic field to change, these switches are inherently faster than ferrite switches. Operating temperature is from −55°C to +125°C.

Please contact Mr. Richard DiBona for specific details relating to your application.

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# Books

(Continued from page 90)

## Governmental Publications

### Translations

(Available from OTS, U. S. Dept. of Commerce).

### USSR Works in the Fields of Radiochemistry and Radiation Chemistry—Isotope Exchange

By A. I. Brodskiy. 60-41141. August 1960. 86 pages. Price $2.25. Translation of an article in Khimicheskaya Nauka i Promyshlennost. Vol. 4, No. 4, 1959, USSR.

### Analytic Investigation of the Processes in a Ferrite Core

By Ye. I. Klepfer and G. M. Tikhomirov. 60-11793. July 1960, 12 pages. Price $.50. Translation of an article from Izvestiya Vysshikh Uchebnykh Zavedenity, Elektromekhanika, No. 12, 1959, USSR.

### Scientific-Practical Conference on Problems of Labor Hygiene

By I. G. Guslits & A. A. Velichkovskiy. 60-41232. Aug. 1960, 3 pages. Price $0.50. Translation of Gigiyena Truda i Professional'nyye Zazolevaniya, USSR.

### New Medical Equipment at the Exhibition in the VNII Mlio.

By B. V. Boldyrev. 60-41477. Sept. 1960. 6 pages. Price $0.50. Translation of Meditsinskaya Promyshlennost', USSR.

### Thromboangitis Obliterans of the Aortic Arch (Takayasu's Syndrome)

By N. I. Sominskiy, V.Ya. Bigeston and others. 60-41580. Oct. 1960. 7 pages. Price $0.50. Translation of Terapevticheskiy Arkhiv, USSR.

### Certain Problems of the Study of Reticular Formation in Connection with the Theory and Proctice of Psychiatry

By A. D. Zurabashvili. 60-41415. Sept. 1960. 10 pages. Price $0.50. Translation of Zhurnal Nevropatologii i Psikhiatrii, USSR.

### The Behavior of a Gyroscopic Stabilizer on a Rocking Base

By A. I. Christyakov. 60-11798. Sept. 1960. 16 pages. Price $0.50. Translation from Izvestiya Vysshikh Uchebnykh Zavedeniy Priborostroyeniye, USSR.

### Super Aero

By V. Smolin. 6-21793. 1960. 15 pages. Price $0.50. Translation of Grazhdanskaya Aviatsiya, USSR.

### Helicopters

By Peter Vladimirovich Kondrat'yev. 60-21940. 1960. 57 pages. Price $1.50. Translation of Vertolety, Moscow, USSR.

### Inertial Systems of Navigation in the USSR: Selected Translations

60-31850. October 1960. 40 pages. Price $1.25. Translation of Akademiya Nauk, USSR.

### The Ecology of Space Flight

By V. I. Danyleyko. 61-31491. 13 pages. Price $0.50. Translated from the USSR's Physiology Journal, Vol. 7, 1961.

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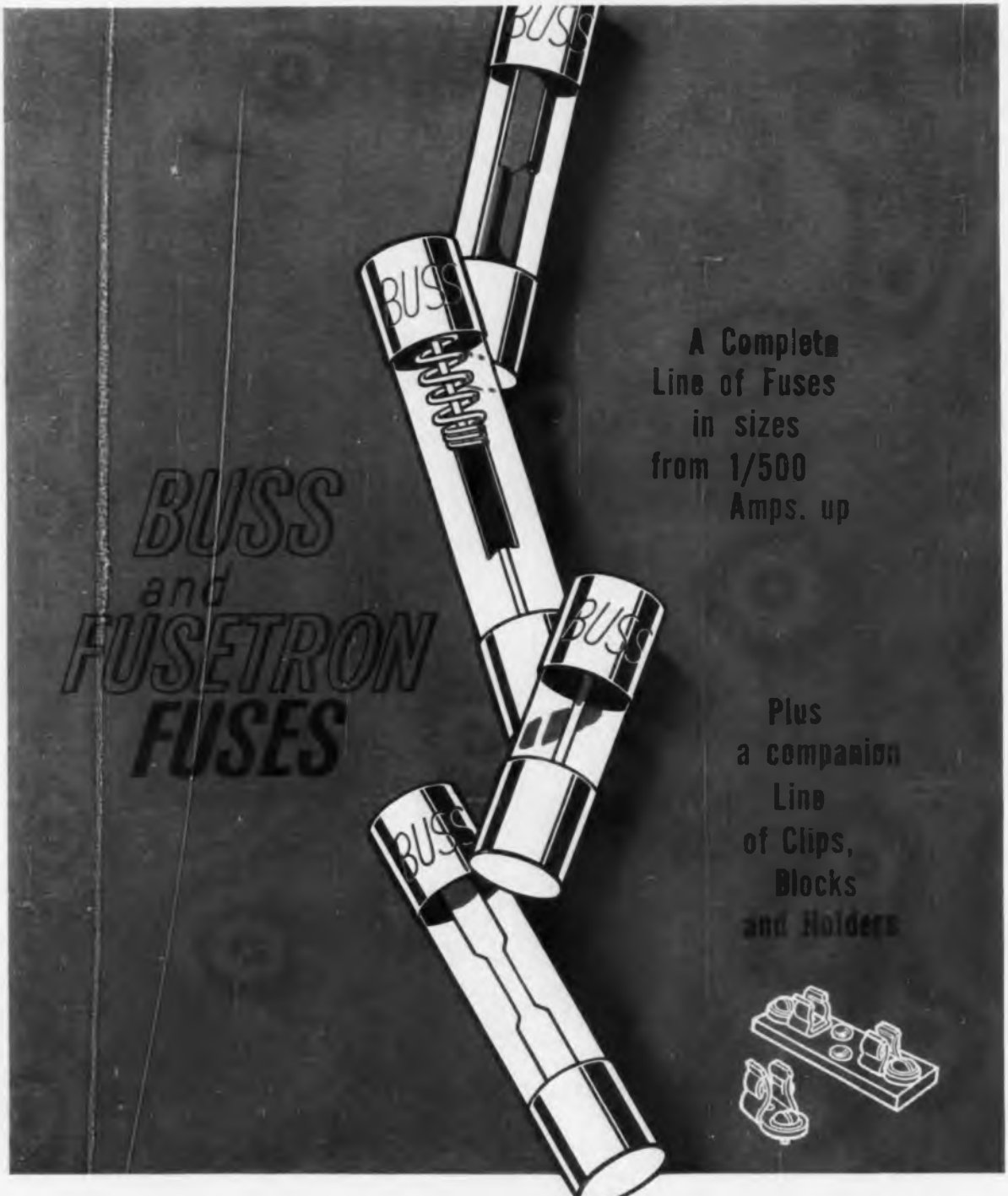


If protective devices fail to protect, costly burnouts may result. Or, if they open needlessly, equipment is put out-of-service. In either case, users may blame the trouble on the equipment and not on the faulty protective device.

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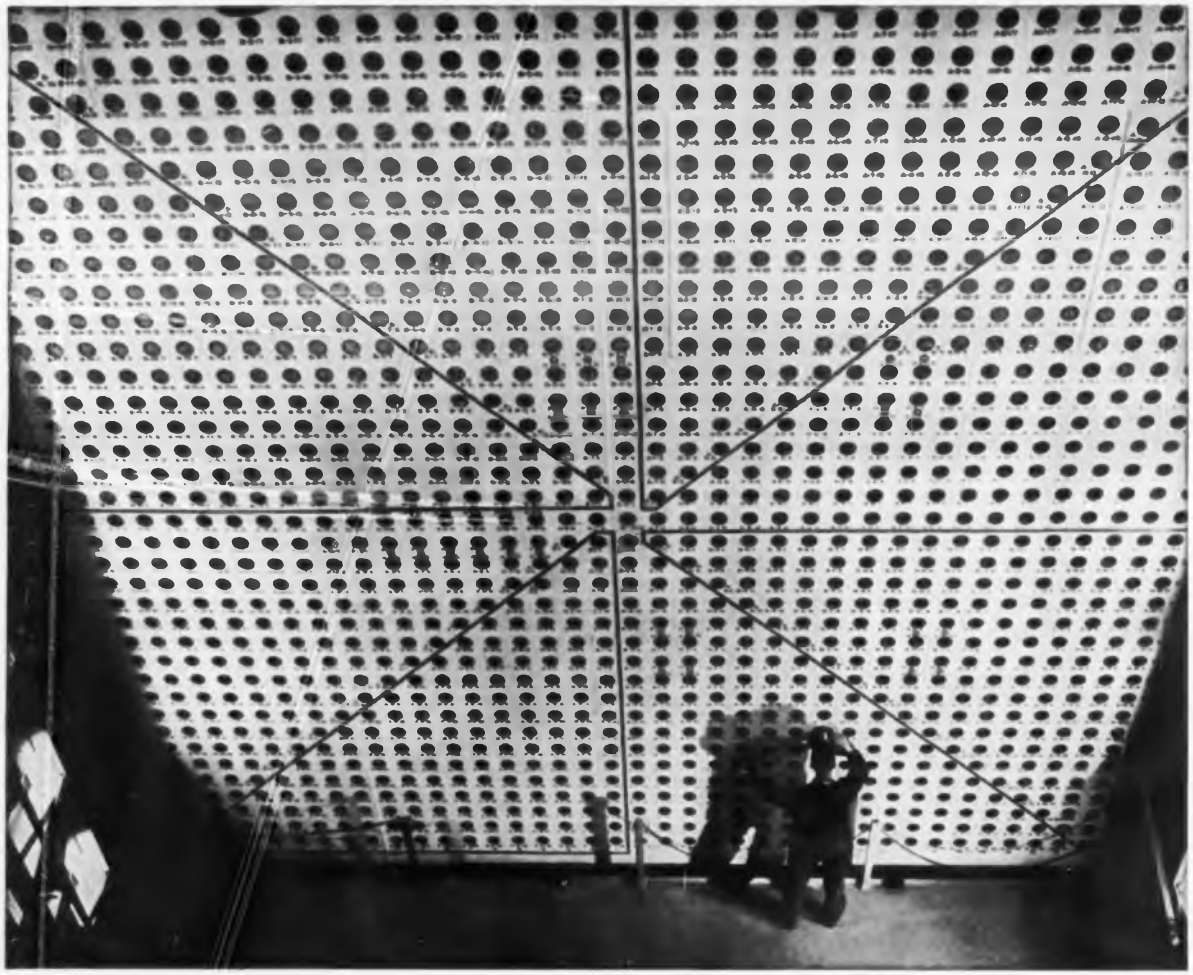

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# Next month

## • EDITOR'S ANNUAL REVIEW AND FORECAST

End-of-the-year survey of the electronic industry, and predictions of business conditions during 1962. A compilation of significant statistics covering the fields of radio-television, semiconductors, receiving tubes, electronic components and engineering employment.

## • VACUUM TUBE VOLTMETERS

Most engineers at some time or other have occasion to use the old standby—the vacuum tube voltmeter! But then the questions arise—What VTVM's are available to the industry? What are their capabilities? What companies manufacture VTVM's? As a result of an industry-wide survey by ELECTRONIC INDUSTRIES, these questions are answered. Company's name, instrument model number and specifications of the instrument are presented in chart form.

## • SPECIFICATION AND USE OF MAGNETOSTRICTIVE DELAY LINES

This article, the first in a series, describes magnetostrictive delay lines and what can be expected from their physical characteristics. No attempt is made to cover the design of delay lines except where this information is necessary to have an understanding required in the specification of requirements and the application of the line to your system.

## • HUMAN FACTORS AND ELECTRONIC COMPUTERS

Following up on our article, "Human Factors in the Electronic Industry," in the February 1960 issue, this article deals with a specific area. The author points out that simple mistakes, which could have been averted by judicious use of competent human factors personnel, ore being made consistently in the design of computers. He examines the areas of programming, operation of the computer, and the allowances that have to be made for the diversity of computers in the field.

### Plus all other regular departments

Our regular editorial departments are designed to provide readers with an up-to-the-minute summary of world wide important electronic events. Don't miss Radarscope, As We Go To Press, Electronic Shorts, Coming Events, EI Totals, Snapshots of the Electronic Industries, EI International, News Briefs, Tele-Tips, Books, Representatives News, International Electronic Sources, Personals, etc.

## COMING SOON

## • SEMICONDUCTOR TESTER SPECIFICATIONS SURVEY

This survey, industry wide and the first of its kind, will include specifications on testers ranging in price from $8.95 to $150,000.00. Units for simple go-no go, the dc parameters, the "h" or all test parameters combined will be specified.

Hand portable, table-top, and large production units with sorting rates in the thousands per hour, digital, printed or scope readout and categorizing capabilities will be featured.

Containing approximately 100 instruments from 35 manufacturers, the survey will be useful and necessary to QC & R, production and design engineers.

Watch for these coming issues:

| *JANUARY | *MARCH | *JUNE |
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| Statistical and Annual Industry Review | Annual IRE Issue | All-Reference Issue |

# Handling Light With...

By O. M. SALATI
*Ass't. Prof. of E.E.*
*Moore School of E.E.*
*University of Pennsylvania*
*200 S. 33rd St.*
*Philadelphia 4, Pa.*

GLASS is currently used in the electronic industry to provide envelopes for vacuum and gas tubes, encapsulating diodes, transistors and component parts and as an insulator for wire or a dielectric foil for capacitors. Glass is suitable for these varied tasks because of its versatility and ease of handling.

A new and much more fascinating use for glass is now emerging. This new product, known as fiber optics, promises to have a vast influence on electronic devices and electrical communications. From the first demonstration by John Tyndall, that light can be conducted along curved paths by suitable materials (a stream of water for instance), to the present-day uses of this principle to conduct light or optical images over tortuous paths, a period of about 90 years has elapsed, with most of the effort occurring in the last 10 years.

A host of electronic developments has resulted from this new technique of fiber optics. Among a few of these are: face plates for cathode-ray oscilloscope tubes permitting a 50 times decrease in photographic exposure time; more efficient coupling of the elements of image intensifiers and infrared or X-ray to optical transducers; better and more rapid punched card or tape readers in data processing systems; shape transducers which permit circle-to-line, or raster-to-line scan; and image viewing in hazardous or inaccessible locations.

The recognition in the last year that waveguide principles are applicable to the analysis of fiber optics promises even more dramatic applications. The most spectacular of these applications may be in communications and computer systems where fiber optics may be used as interconnecting "wires" and logical components.

### *General Theory*

The analysis of light transmission in transparent media can be carried out by electromagnetic theory or in certain simple cases by the methods of geometric optics. The first method considers light conducting fibers (light guides) as dielectric waveguides. The second approach, that of ray tracing, is useful if the diameter of the fibers is many times the wavelength of light. It will now be applied to a few simple examples.

If a ray of light crosses a boundary between two transparent media of indices of refraction $N_1$, $N_2$ where $N_2 > N_1$, the ray is partially reflected and partially transmitted as shown in Fig. 1a.

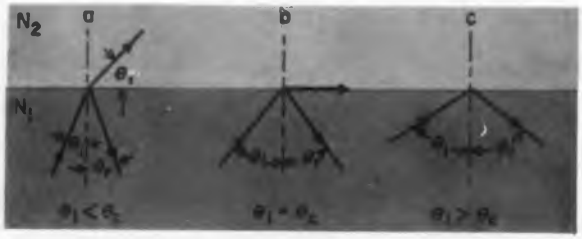
For the reflected wave, the angle of incidence $\theta_i = \theta_r$ the angle of reflection, and the angle $\theta_t$ of the transmitted or refracted ray is given by Snell's Law:

$$N_1 \sin \theta_i = N_2 \sin \theta_t \qquad (1)$$

From this equation it can be seen that if the angle of incidence $\theta_i$ = a critical angle $\theta_c$ such that $\theta_t = 90°$, then:

$$\theta_c = \sin^{-1} \frac{N_2}{N_1} \qquad (1a)$$

and the refracted ray now becomes a surface wave along the interface boundary between the two media (Fig. 1b). If $\theta_i > \theta_c$, total reflection occurs at the interface boundary as shown in Fig. 1c and no light is




$N_2 > N_1$ ; $\theta_i = \theta_r$
SNELL'S LAW: $N_1 \sin\theta_i = N_2 \sin\theta_t$
CRITICAL ANGLE = $\theta_c = \sin^{-1} \frac{N_2}{N_1}$

Fig. 1: Plane wave crossing an interface between two transparent media having different indices of refraction is shown.

transmitted into the second medium, that is, the incident ray is trapped in the first medium. This latter property is the backbone of fiber optics.

The amount of unpolarized light reflected or lost at the interface boundary in Fig. 1a is given by the reflection coefficient $\rho$ from Fresnel's equation:

$$\rho = \frac{\sin^2(\theta_i - \theta_t)}{2\sin^2(\theta_i + \theta_t)} + \frac{\tan^2(\theta_i - \theta_t)}{2\tan^2(\theta_i + \theta_t)} \qquad (2)$$

For normal incidence, that is $\theta_i = \theta_t = 0°$, Eq. 2 becomes:

$$\rho' = \frac{(N_2 - N_1)^2}{(N_2 + N_1)^2} \qquad (3)$$

This equation is independent of the plane of polarization of the light and holds for unpolarized light also. There will be a similar reflection loss at every interface boundary.

### *Straight & Bent Optical Fibers*

If an incident ray intersects the axis of a circular cylindrical fiber (meridional ray) at an angle $\theta_i$ to the axis, Fig. 2, the ray will be conducted along the interior of the fiber by multiple reflections providing $\theta_i < \theta_{max}$ where:

*Fiber optic devices are beginning to emerge, with the most common being CRT face-plates. There are many devices, with applications in the electronic field, in some stage of development. Here is a rundown on some of these devices along with concise information on how fiber optics "works."*

# FIBER OPTICS

$$\theta_{max} = \sin^{-1} \frac{\sqrt{N_2^2 - N_1^2}}{N_1} \quad (4)$$

and the exit angle $\theta_e = \theta_i$. The above phenomena is true for both straight and bent fibers providing the bending radius is greater than 20 times the fiber diameter $d$.

If the incident ray enters at an angle $\theta_i > \theta_{max}$, part of the ray will escape from the fiber and thus represent a loss of light. This escaping light accounts for the silky appearance of the fibers.

If rays enter the fiber such that they do not intersect the fiber axis (skew rays), their path down the fiber will be helical and they will contribute to the exit light. Skew rays will escape the fiber walls before meridional rays when the fiber is bent.

### *Light Losses in Optical Fibers*

Light will be lost from optical fibers at the incident and exit surfaces as shown earlier. The reflection loss given by Eq. 3 will occur at each entrance or exit surface. The total reflection loss for the fiber of Fig. 2a is:

$$\rho'' = 1 - (1 - \rho')^2 \quad (5)$$

This loss can be reduced by the use of low reflectance coatings at the incident and exit surfaces.

There will also be a loss of light when the incident angle $\theta_i > \theta_{max}$ or when skew rays are present. The latter loss will be greater if the fibers do not have a circular cross section or if the bending radius of the fiber is less than 20 times the fiber diameter.

A small light loss will occur at the internal reflection interface if the fiber surface is not absolutely smooth and clean. In order to keep the surface clean, it is frequently clad with another material. This is discussed more fully later.

A further loss of light is caused by attenuation within the optical material itself. This loss will depend on the length of the optical path, the angle of ray incidence and the coefficient of absorption of the optical material. Referring to Fig. 2a this loss is given by:

$$\frac{E_t}{E_e} = \exp \left[ \frac{-\alpha L}{\sqrt{1 - \left(\frac{\sin \theta}{N_2}\right)^2}} \right] = \exp (-\alpha L \sec \theta_i) \quad (6)$$

Where $E_t$ = the transmitted light.

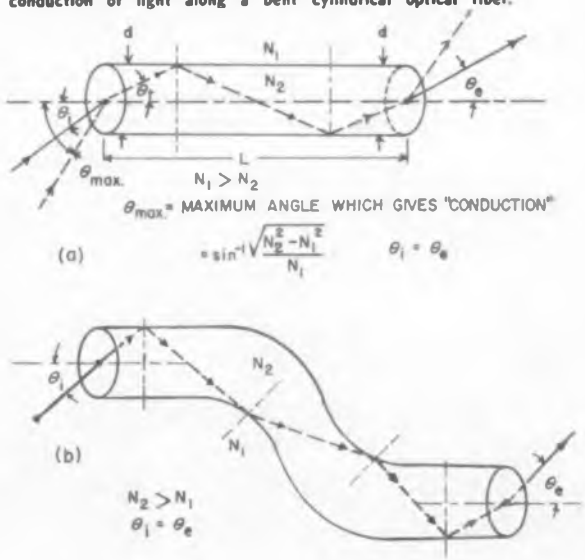
$E_e$ = the incident light.

$N_2$ = Index of refraction of the fiber.

$\alpha$ = Coefficient of absorption of the optical material, and $L \sec \theta_i$ = the total path length of a ray in a fiber of length $L$.

It can be seen that this loss does not depend on the fiber diameter.

**Fig. 2: Conduction of light along a straight cylindrical optical fiber is shown in top drawing. Bottom drawing shows the conduction of light along a bent cylindrical optical fiber.**



# Fiber Optics *(Continued)*

For a 7 ft. fiber having a refractive index of 1.71, a 50 micron diameter, a transmission coefficient of 99.5%/in. of path and a numerical aperture of 0.25, the light loss is about 50% in the yellow-green region of the spectrum.

### *Fiber Bundles*

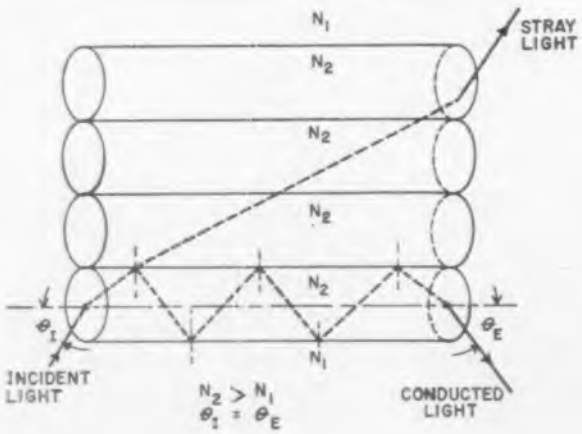
For many applications of fiber optics, the technique of image dissection is used, that is, each fiber of a bundle of fibers is required to transmit an element of the scene or phenomena being observed. This technique will be successful only when each fiber carries its information without coupling or "cross-talk" from other fibers.

A bundle of optical fibers assembled in an orderly array is shown in Fig. 3. Our simple ray theory of light implied that total internal reflection would occur as long as the angle of incidence was greater than the critical angle. When simple uncoated fibers are placed close together, however, some light does cross from fiber to fiber as shown in the figure. In the wave theory of light this is easily explained, because at the interface between two different media, a set of boundary conditions must be satisfied which require that a portion of the light wave enter the second medium (diffraction phenomena).

This cross-talk between fibers can be reduced to a very low value by coating the fiber with a layer of optical material, whose index of refraction is lower than the fiber index as shown in Fig. 4. This layer must be one or two wavelengths thick to be effective. The layer not only reduces cross-talk but also protects the highly polished and clean fiber surface from contamination and damage, and thus reduces losses at the points of internal reflections. The maximum acceptance angle for the coated fiber is given by (Fig. 4):

$$\theta_{o\,max} = \sin^{-1} \frac{\sqrt{N_1^2 - N_2^2}}{N_o} \qquad (7)$$

Fig. 3: Conducted and stray light is shown in a bundle of closely packed, unclad optical fibers. $N_3$ here is air.




This also defines the numerical aperture N.A. of the fiber, that is:

$$N.A. = N_o \sin \theta_{o\,max} \qquad (8)$$

The square of the numerical aperture is a measure of the light gathering ability of an optical system. The light gathering ability of a lens is given by its f/number, which may be defined as:

$$f/\text{number} = \frac{1}{2\,N.A.} \qquad (9)$$

For a typical clad fiber in air, $N_1 = 1.75$, $N_2 = 1.52$, and $N_o = 1$, so that $N.A. = 0.86$ corresponding to a lens speed of f/0.58. It is then easy to see that such fibers have much higher "speeds" than the best lenses.

### *Tapered Fibers*

In the manufacture of optical fibers, the fiber diameter may vary along the length of the fiber. The resulting tapered fiber is shown in Fig. 5. Notice that the angle of the exit ray is no longer equal to the angle of the incident ray. In particular, the maximum angle at which a ray may be incident on the large diameter face and still be conducted through the fiber is given by:

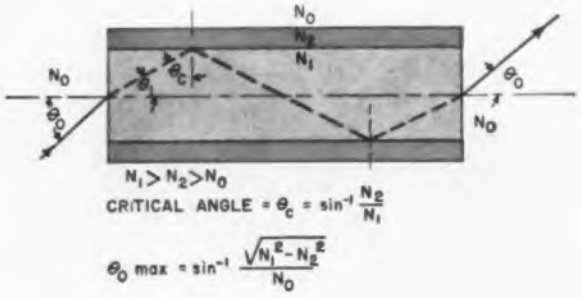



Fig. 4: Coated fibers reduce cross-talk between fibers.

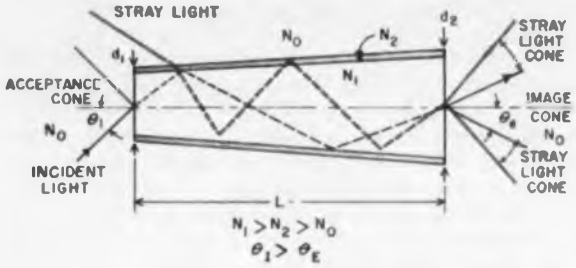
$$\theta_{i\,max} = \sin^{-1}\left[\frac{d_1 N_1}{d_2 N_o}\sqrt{1 - \left(\frac{N_2}{N_1}\right)^2}\right] \qquad (10)$$

If this angle is exceeded, the ray will penetrate the fiber boundary as shown by the stray light ray in Fig. 5. Conversely, stray light may enter the fiber boundary and appear as a stray light cone at the exit aperture. Such stray light will degrade the contrast ratio of the desired image, as well as contribute to further light losses in the system. For some fiber optic applications, this means that the variation in diameter along the fiber may need to be less than 5%.

In other applications, however, a deliberate tapered fiber or fiber bundle is required. For instance, to magnify or demagnify an image or to concentrate or spread out a light source as shown in Fig. 6. For these applications, the entire bundle may be given an opaque coating, or the individual fibers may have an opaque (usually metallic) coating over the normal optical glass coating.

### *Resolving Power*

The resolving power of a fiber bundle, when viewing a static image, is given by:




$$W = \frac{1}{2D} \text{ lines/unit length} \qquad (11)$$

$D$ = fiber diameter

If dynamic scanning is used, that is the image is moved in a random fashion with respect to the bundle, the resolution is increased and becomes approximately:

$$W = \frac{1.22}{D} \qquad (12)$$

A significant improvement is thus possible, as shown in Fig. 7.

If two or more fiber optic devices are placed in series, a further reduction in resolution occurs. This is due to the random orientation of the fibers in each of the cascaded devices. The overall resolution of the system is given by:

$$\frac{1}{W^2_{\text{system}}} = \frac{1}{W_1^2} + \frac{1}{W_2^2} + \cdots \frac{1}{W_n^2} \qquad (13)$$

where $W_1$, $W_2$, $\cdots W_n$ = resolution of the individual devices.

In terms of fiber diameter, because of random coupling, this becomes approximately:

$$D^2_{\text{system}} = d_1^2 + d_2^2 + \cdots + d_n^2 \qquad (14)$$

where $d_1$, $d_2$ $\cdots$ $d_n$ = fiber diameter in individual devices.

G. *Area Efficiency*

In fiber bundles, the area efficiency $E_a$, that is the ratio of total core material $A_c$ to total area of bundle $A_b$, is of importance since only the core transmits useful information.

$$E_a = \frac{A_c}{A_b} \qquad (15)$$

$E_a$ ranges from 70 to 92%. The sheath glass and matrix filler only transmit unwanted light. Since the sheathing thickness is fixed at one or two wavelengths, the smaller the core diameter, the smaller the area efficiency, and thus the smaller the amount of useful light.

Fig. 5: Light rays are traced through a tapered, coated optical fiber.


Fig. 6: A tapered fiber bundle can be used to magnify or demagnify an image.

(Photo courtesy of American Optical Co.)

### *Materials*

Materials that have been used in fiber optics are: quartz, glass, optical crown glass, tellurium-dioxide glass, arsenic-trisulfide glass, arsenic modified selenium glass, silver chloride, various alkali-halide crystals, magnesium oxide, calcium-aluminate glass, Kel F, germanium, and silicon. Not all of these materials have been used successfully. Considerable difficulty has been experienced in producing fibers of optical quality from silver chloride, magnesium oxide, germanium and silicon. The major difficulties are the techniques for drawing or extruding these materials in the proper range of sizes and adequate surface quality.

The above materials permit the transmission of energy over the wavelength range of 0.25 to 25 microns (near ultraviolet to infrared). Most fibers are made in the range of 0.38 to 2.7 microns. Materials for the range of 2.7 to 25 microns are still in the development stage and are the least satisfactory.

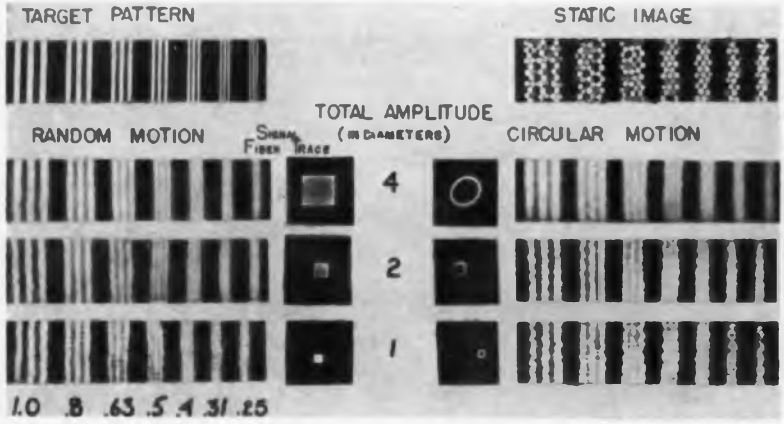



Fig. 7: Dynamic vs. static scanning. Dynamic scanning (moving the image in respect to the fiber bundle) increases the resolution.

(Photo courtesy of Optics Technology, Inc.)

Fig. 8: A coherent fiberscope in operation without a covering.
*(Photo courtesy of Bausch & Lomb)*

Fig. 9: Typical fiber bundle before surfaces are finished.
*(Photo courtesy of American Optical Co.)*

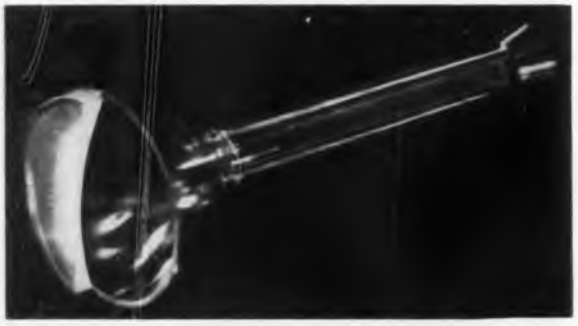


Fig. 10: Cut-away of a CRT with a fiber optic face-plate.
*(Photo courtesy Monsico, Inc.)*

Fig. 11: Shaped beam tube has a fiber optics strip imbedded in the face-plate. Tube is used for high speed data recording.
*(Photo courtesy of General Dynamics/Electronics)*

## Fiber Optics *(Continued)*

### *Fiber Size*

Most fibers have a near circular cross section, but some are square. The fibers are usually coated with a one or two wavelength thickness of material having a lower index of refraction than the core fiber. Some fibers may have a metallic coating over the core sheath. and in some cases the fiber is a metallic core with a glass sheath.

Fiber diameters range in size from two or three microns ($10^{-3}$ millimeter) to 50 microns. Fibers as small as 0.125 microns and as large as 200 microns have been made. In the smaller fibers, pronounced waveguide mode patterns are observed. Small diameters (less than 2 or 3 microns) are difficult to make at the present time.

### *Light Attenuation*

Little information is available on the attenuation of infrared energy in fibers. In the visible spectrum (0.4 to 0.7 microns,) absorption of the order of ¼% to 1 or 2% per inch of fiber has been reported. The ¼% figure in the yellow-green region of the spectrum, corresponds to a loss of 50% in 7 ft. of fiber or about 42.8 decibels/100 ft. of fiber.

Common attenuation figures for coaxial cables and waveguides are of the order of 0.1 to 6 db/100 ft of line. It is believed, however, that smaller diameter optical fibers, properly excited with the lowest attenuation mode of propagation in a dielectric waveguide, may have significantly lower attenuations than presently available fibers.

### *Fiber Optic Assemblies*

Optical glass fibers have been used as individual fibers, incoherent fiber bundles (light guides) suitable for conducting light, coherent fiber bundles such as fiberscopes, cathode-ray tube face-plates, and various shaped transducers. The coherent bundles can preserve an image.

Light Guides can be made in any reasonable length and in almost any bundle size. For this application coarse fibers are satisfactory. Fig. 8 illustrates a typical light guide.

Fiberscopes can be made in lengths of 1 to 12 ft. and in cross-sectional areas of ⅛ x ⅛ in. to 1 in. square. Usual fiber sizes are 5 to 50 microns. A typical fiber bundle is shown in Fig. 9.

Coherent Fused Tapered Fiber Bundles are illustrated in Fig. 6. They have been made with magnifications or demagnifications of about 5 to 1. They are used in direct contact with the image being viewed and have very flat fields.

Coherent Fused Fiber Bundles or face plates have been made in sizes up to 5 in. in diameter and ¼ in. x 8 in. rectangles. The practical range of fiber diameters is 5 to 75 microns, but diameter below 5 microns have been used.

### *CRT Face-Plates*

The resolution and time to make permanent recordings of cathode-ray oscilloscope traces depend on the electron optics, light diffusion in the thick face-plate, halo, and reflections from the glass face. Because the

face-plate is thick, there is also the possibility of parallax error. These factors make it necessary to use a lens to focus an image on film.

If a fused coherent fiber optic face-plate is used and the phosphor deposited on its rear surface, any light spot or image produced by the electron beam will appear in dissected form on the front face of the face-plate. It can be used to expose a suitable film placed in contact with the fiber optic face-plate (see Fig. 10). This procedure results in a reduction of about 50 to 1 in exposure as compared with the use of the same type film in a camera having an f/2 lens. In addition, contrast has not been lost because halo and front glass reflections are absent and parallax is non-existent. The only apparent loss is the dissection of the image because of the finite size of the fibers. This in time may be improved sufficiently to be unimportant.

A fiber optic face-plate then permits the taking of faster pictures or the use of lower intensity traces, as in single transient recording. The face-plate is initially more expensive than a conventional face-plate but the recording "camera" can be considerably reduced in price since a lens system is not required.

### *High Speed Printing*

The above mentioned cathode-ray tube with a fiber optic face-plate can be used as a non-impact printer for computer and data processing systems. The computer output is translated to suitable characters on the face of the tube. A recording is made by passing a suitably sensitized paper over the fiber optic face-plate. For the two embodyments of this method disclosed thus far, the face-plate consists of a relatively narrow rectangle.

In one system, the face-plate is made up of several rows of glass coated metallic wires. An electric current sensitive paper moves in contact with the wires. When the electron beam of the tube scans a suitable character, a current is conducted along appropriate fibers to the sensitive paper and a recording is made.

In the other system, the face-plate consists of several rows of coated glass fibers and an exposure is made in conventional fashion on a light sensitive paper or film. This system has the advantage of not necessarily requiring contact with the face-plate, since the fiber optic system has some depth of focus.

Typical tubes are illustrated in Fig. 11. The printing speed of the above devices is of the order of 20,000 to 100,000 characters/sec.

**Fig. 13: Fiberscope is coupled to a closed-circuit TV so that observers have a good view of the patient's teeth.**
*(Photo courtesy of AVCO)*

### *Image Intensifiers or Converters*

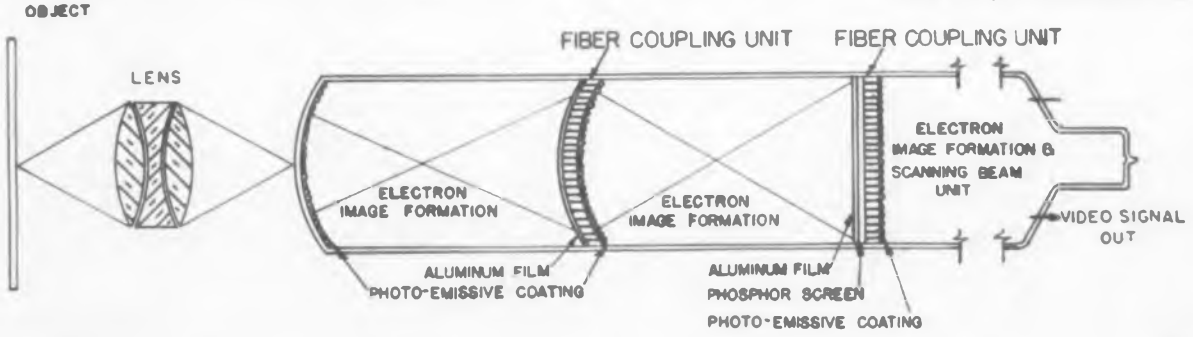
In Image Intensifiers and Image Converters (conversion of infrared, ultraviolet or X-rays to visible light) a primary photo cathode is illuminated by an image, and its output is amplified by one or more intensifier stages. The tube also incorporates a storage target which is scanned by an electron beam to get a video output.

In conventional tubes, thin glass windows are used to couple the various stages and thus these tubes have the disadvantages mentioned above for cathode-ray tubes. Fig. 12 illustrates a tube incorporating fiber optic face plates in place of the thin glass windows. This procedure results in an improvement in resolution and photometric efficiency.

### *Image Orthicon, Vidicon Tubes*

The use of fiber optic face-plates on image orthicon and vidicon tubes has some of the same advantages that are found in the preceding applications, that is, reduction of parallax and increase in optical efficiency.

**Fig. 12: A sketch of a multi-stage image intensifier that uses fiber optics coupling for improvement in resolution and photometric efficiency.**
*(Photo courtesy of Optics Technology, Inc.)*



# Fiber Optics *(Concluded)*

In addition, the fiber optic face-plate permits the tube to be directly coupled to a fiberscope.

The combination of image orthicon and fiberscope gives the direct advantage of a light, small optical probe that can be used in inaccessible locations. It has the ability to present the image to a large or remote audience by closed circuit TV techniques. Such an application has already been developed for the Navy to aid dentists in diagnostic, operative, and instructional use. This application is illustrated in Fig. 13.

A further application, incorporating an X-ray image converter is being studied as an aid in reducing the X-ray dosage to both patient and doctor in X-ray examination of teeth.

### *Shape Transducers*

A line-to-raster or circular scan fiber optic transducer can be used with a cathode-ray tube or image orthicon as a facsimile reader or printer. This is illustrated in Fig. 14. By this means, the resolution of reading can be improved since the line scan can now fill the entire tube face instead of just a tube diameter. By suitable design of the fiber optic transducer, large size copy could be handled by a standard machine.

### *Punched Card & Tape Reader*

Present punched card readers have reading speeds of 600 cards/min. with mechanical scanning or 2000 cards/min. with standard optical techniques. Much faster card reading would be possible if the cards could be read while they are being transported transverse to card length, but the information is transscribed sequentially. This is done by having a fiber optic bundle placed behind each card hole location and then arranging the opposite ends of the bundles in a circular array, such that the bits of a given character are adjacent to each other and in sequence. When the circular array is scanned, the bits of character are read-out in sequence.

### *Other Applications*

There are many other applications too numerous to describe in detail. Some of these are in the very early development stage and thus it would be premature to do more than mention them. Among these are: Magneto-Optic rotation of the plane of polarization in a glass fiber to get a high speed optical switch or light modulator, the use of glass fibers as "wires" to interconnect the parts of a digital computer so as to gain the advantages of low cross-talk, high speed random access memories, and the interconnection of telephone exchange by fiber optic cables.


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Fig. 14a: A line-to-raster transducer using fiber optics.

Fig. 14b: Line-to-circle transducer can be used for facsimile.

*The semiconductor industry is bedeviled by surface state properties which are difficult to control. Most transistors are limited by the surface state effects caused by unknown adsorbates, trace contaminants. This article shows how to handle and identify very low concentrations of impurities.*

# Ultramicroanalysis

**By JAMES S. PELLE**
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*Lockheed Aircraft Corp.*
*Burbank, Calif.*

IN many electronic applications of surface state phenomena and thin film structures, low concentration contaminants play a large part. The chemical compositions usually relate to contaminants of the order of 1 part in $10^4$. It is clear then that we need to know compositions up to one part in $10^6$ parts in many instances; for semiconductors, we deal with carriers 1 part in $10^8$, $10^{14}$ carrier atoms per $cm^3$ of semiconductor, and even less. This is rather dismaying when ordinary chemical analysis commonly works in the neighborhood of 1 part in $10^5$.

Even with the cleanest material we have to deal with surface adsorption; at its best, the surface contains a monolayer adsorbate. This is true even for high-vacuum conditions. Therefore, let us consider the question: *Can we identify and estimate surface adsorbates of the order of a monoatomic layer about 1 $cm^2$ in area?*

For an average substance we have $10^{21}$ atoms per $cm^3$, $10^7$ atoms to the cube edge, or $10^{14}$ atoms per $cm^2$ per monolayer. Given a $cm^2$ of surface, can we detect and estimate $10^{14}$ atoms? Or, still more difficult, can we detect a 1% monolayer, $10^{12}$ atoms, which is $10^{-10}$ grams?

Thermionic emission and the electron work function are affected by a 10% monolayer, e.g., oxygen and caesium on tungsten emitters, as shown by Irving Langmuir, Becker and others. There is good reason to suppose that such a quantity may affect semiconductor characteristics as well, namely, the potential difference between bulk and surface material. Also, the more sophisticated semiconductor electrical measurements are just capable of estimating this order of magnitude of carriers, $10^{14}$ per $cm^3$.

It would be of some interest to know if we can do the same or better by some other physical or chemical means, simply and preferably without elaborate apparatus.

### *Techniques Examined*

The following techniques and methods were examined:

(1) Feigl color spot analysis, which employs reagents highly specific for a given element, and can work in the range of $10^{-8}$ grams.[1]

(2) Crystallographic microanalysis, which depends on the characteristic crystal habits of certain compounds, as well as color, crystal group, refractive index, etc. The range is $10^{-6}$ grams in ordinary practice, but can be made smaller, up to the limit of resolution of the microscope.[2]

(3) The mass spectrograph, the omegatron, and Bennett electron tubes,[3] and other time of flight or cyclotron devices. Devices especially suited to gases of low molecular or atomic weight, or weights of a limited range.

(4) Microvolumetric analysis, Benedetti-Pichler,[4] and the A.E.C. reports, $10^{-6}$ grams.

(5) Radioactivity analysis, $10^{-9}$ grams.

(6) Gas discharge spectrum analysis. A very wide range of sensitivity depending upon the element and technique.

(7) Surface chemical reactions on water, $10^{-8}$ grams.

(8) Electron reflection diffraction.[5].

(9) Some other methods were examined, such as polarographic, flame and chromatographic analysis. Gas chromatography is capable of $10^{-7}$ grams.[6]

### *Acceptable Techniques*

All of these systems are capable of high sensitivity in some areas, and all of them have been eliminated as either too costly in time and equipment, or too specialized and limited, except for systems 2 and 6.

The gas-discharge method seems most promising, especially for confined vapors and plasmas. This would entail no change in the principles of present-day practice; nonetheless, a major change in technique, method


and equipment. For gases and other volatile substances, e.g., in a high-vacuum system, the desorbed vapors are pumped into a small discharge tube and energized as long as necessary to obtain the necessary spectrum line exposure for the film. On the other hand, the nongaseous components pose a difficult problem.

The sensitivity of crystallographic microanalysis is $10^{-6}$ grams in ordinary practice,[7] and inadequate for our purposes. The technique for handling trace quantities, though clever and simple, is still somewhat crude. However, its potentialities are singular; it is capable of great improvement.[8]. We can observe and resolve the shape, size and color of a 10-micron cube microscopically. The resolution of the light microscopes is of the order of 1 micron, $10^{-4}$ cm, and a 10-micron cube is $10^{-9}$ $cm^3$, or $10^{12}$ atoms, or $3 \cdot 10^{-9}$ grams, which we can estimate by volume, employing microscope eye-piece micrometers.

Thus we can see a 10% monolayer of 1 $cm^2$ area, if it is collected together and well within the limits of the microscope. If we can carry out and follow chemical reactions involving such quantities, it is clear that we must employ some radical and yet simple techniques[9] which we shall consider shortly.

The next question arises: *Can we identify quantities of the order of $10^{12}$ atoms?* We shall attempt *a defacto* answer to this question by the following experiments. All the reactions were carried out in a volume of solution $\cong$ to $10^{-2}$ $cm^3$ on a microscope slide or in capillaries. The solutions were transferred back and forth, via micropipettes, in freshly drawn glass capillaries.[10] The reagents were hermetically sealed in glass, and all addition and subtraction of material was done via glass. The microscope used was the Reichart, a research quality instrument, at a magnification of 100 - 300x. No attempt is made to use the instrument at its limit of resolution, or at the limit of magnification.

### First Element Studied

The first element we shall study is chromium: namely, what is the smallest quantity we may detect in a volume of $10^{-2}$ $cm^3$?

From the metal or compounds, form the Cl or $SO_4$, concentrate, and fuse to red heat, 800° C., with a few mg. of $NaNO_2$ on a glass fiber. Wet methods of forming $CrO_4$ are uncertain. Five micrograms of $CrAc_3$, chromium acetate, will color a 2 mg. melt the typical chromate yellow. One mg. $CrO_4$—in 5 cc. is a detectable yellow when compared with pure $H_2O$.

The melt is now dissolved in a drop of water to which we shall add several reagents. For each reagent the Cr content will be reduced until the detection limit is reached.

### $AgNO_3$ Reagent

Dissolve the melt in $H_2O$, + $HNO_3$, + $AgNO_3$ crystal, to produce the characteristic $Ag_2Cr_2O_7$.[11]

One microgram of $CrAc_3$, treated as above, will not yield the $Ag_2Cr_2O_7$; instead, long 10 x 1 x 1 needles, crosses and stars are obtained, transparent and clear; chromate color fluid edges are observed before needdles precipitate. $10^{-6}$ grams of $CrAc_3$, or greater, will yield $Ag_2Cr_2O_7$ ruby-red cline crystals, or bipyramids, a unique crystal habit.

The most insoluble $CrO_4$—are Ra, Pb and Hg, by calculation.

### $PbCl_2$ Reagent

The reagent was applied as crystals to a Cr solution. $PbCrO_4$ sulphur-yellow, granular at first, then feathers and feather-needles. $10^{-7}$ grams of Cr can be detected, precipitated on $PbCl_2$ crystal surfaces. There is no unique character to the $PbCrO_4$.

### $Hg(NO_3)_2$ Reagent

$HgCrO_4$, $10^{-7}$ grams, granules unresolvable at 320x. Precipitates on drop surface and in solution as orange-red roses, very thin circles and spheres, which appears to be a specific and characteristic. $Hg(NO_3)_2$ reagent is quite pale yellow for 2 micron size crystals, and rhombic.

### Diphenyl Carbazide

Applying crystals to $H_2SO_4$ acid chromate, $7 \cdot 10^{-7}$ will yield a decidedly violet color; $2 \cdot 10^{-8}$ will not. The violet seems to be in solution, and turns yellow-brown in 15 minutes. This detection limit confirms the results of Feigl.[12]

### $BaCl_2$ Reagent

At $10^{-9}$ grams of $K_2CroO_4$, $BaCl_2$ will sometimes yield enough yellow $BaCrO_4$, especially at the high points. Typical high points are at the top of a $BaCl_2$ crystal pile. This is for a neutral solution. Made slightly acid with $HNO_3$, the deep red of $BaCr_2O_7$ can



be seen, also at concentration sites, a pile of $BaCl_2$ crystals. All of this was seen for $BaCl_2$ in excess by 1000 times the quantity of $K_2CrO_4$. The crystal habit of $BaCrO_4$ and $BaCr_2O_7$ is not unique.

Thus, we can detect a 10% monolayer of Cr, 1 $cm^2$ in area, but not a 1% monolayer ($10^{-10}$ grams).

### Second Element Studied

The second element chosen was the nickel and dimethylglyoxime reaction, to answer the question on test limits and the question: *Does silicon adsorb the extant ions in etching solutions, traces of iron, nickel and cobalt?*

The discussion will revolve about only one reagent, the chelate agent dimethylglyoxime, Dg. This reaction and compound, NiDg, is unique in several re-

spects. Firstly, it is a specific reaction, i.e., with Dg no other element will yield the red acicular crystals of a peculiar shape and habit as Ni does. Modern chemical analysis has discovered a number of such specific reagents.[18]

The specimen is brought into solution with $H_2SO_4$, $HNO_3$, or HCl; then an excess of $NH_4OH$ is added which complexes with Ni, and this complex is quite soluble. Crystals of Dg are added to this Ni solution, and again we shall find the detection limit. For Si crystal slabs, $H_2O$, $NH_4OH$, and Dg solution was applied directly to the surface.

A solution of nickel, $10^{-6}$ grams per drop, can be detected with dimethylglyoxime without a microscope!

An excess of the reagent is often used in practice and the same was tried in this case. On reducing the Ni content, in a $10^{-2}$ $cm^3$ drop, the detection limit was near $10^{-8}$ grams, for this case.

### *Important Effects*

Two peculiar and most important effects were noticed. The first effect: a recrystallized Dg changed its crystal habit, forming large mono- or triclinic crystals. It was suspected and confirmed that Dg forms a solid solution with NiDg. On reducing the Dg content to $\cong$ the Ni content, the detection limit was lowered to less than $10^{-8}$ grams. This solid solution effect becomes ever more important as we reach for lower limits. By controlling reagent concentration the test limit can be extended several orders of magnitude.

The second and more interesting effect: when the crystal size of NiDg is reduced to near micron dimensions, the characteristic red color of NiDg gives way to a green color, an apparently fluorescing green. A single crystal may have both colors. There are some theoretical arguments which anticipate such an event, a radical change of physical and chemical properties for small particles when the "surface phase" thickness predominates over the bulk phase of a crystal. It appears that we may have an illustration of this size effect in NiDg.

This phenomenon, though relatively unknown, should be common. The theory predicts such events for crystals in the micron range or smaller; specifically, a different heat capacity, higher entropy and enthalpy, a higher solubility and vapor pressure, an increasing isotropy, for the small crystal. That is, a non-isotropic large crystal of a characteristic crystal group and habit becomes more and more isotropic as its size diminishes after reaching critical size. The habit (shape) changes; namely, the ratio of the 3 axes $\rightarrow$ 1. In NiDg we have not attained this end as yet, a ratio of width to length equal to 1, but we do have the color change. From the quantum mechanics of the solid, the Debye theory, the long waves must be cut off as we reduce the crystal size, and the Debye spectrum waves from the "red" to the "blue"; or said otherwise, for the Einstein solid, the characteristic frequency shifts to a higher value, the "blue." Thus far, we have no quantitative confirmation of this theory—it is that new.

To return to our microanalyses, the crystal habit of green NiDg is similar to the red, long crystals with pointed terminations, which crystallized on the surface of the drop as well as in the drop. The fluorescing green is observed in polarized or plain light. The width-length ratio seems to follow theory, but more exacting measurements are needed before any conclusions are warranted.

We can detect $10^{-11}$ grams of Ni, providing that too much reagent is not employed. $10^{-4}$ $cm^3$ of half conc. $NH_4OH$ sat. with dimethylglyoxime may be used; $10^{-2}$ $cm^3$ is in excess. With a quantity of reagent such as $10^{-2}$ $cm^3$, $10^{-9}$ grams of Ni is necessary. At $10^{-10}$ grams of Ni, the dimethylglyoxime becomes highly prismatic, long cline crystals. At these limits of Ni, the typical red needles of the commonly known Ni salt are never seen, but rather the grass-green crystals, and the length-width ratio varies with Dg content, or due to the size effect.

### *Detection Limit*

The detection limit was not pushed any farther than $10^{-12}$ grams, although it is quite evident that it could reach $10^{-13}$ grams with more refined techniques, at higher resolution and magnification.

The practical limit of microcrystallographic analysis seems to be $10^{-12}$ grams.

By the above method it was demonstrated that a silicon die adsorbs Ni to the amount of $10^{-9}$ grams, and as high as $10^{-7}$ grams in spots. The reaction was carried out *in situ*, on the die of Si itself. The same and other metals also color phosphorus-doped silicon. The source of the Ni adsorbed is unknown and it is probably fruitless to search for it, for such trace quantities appear to be everywhere. The same applies to copper, iron, silver, and others.

The results of the chromium and nickel analysis are considerably more encouraging than was anticipated.* It appears that one may improve the detection limits of most crystallographic tests, but not all. Most of them are not specific enough, or the compound is too soluble. A systematic investigation of solubility was made, and it may be shown how to predict highly insoluble compounds. But there is no way, at present, to predict specific reactions.[14]

* It demonstrates clearly what can be done, with practically no apparatus. This technique was carefully examined, and it was found: the operations are quicker, safer and simple; and nearly all chemicals may be stored on filing cards. All slow organic reactions may be answered by sealing in a glass capillary and heating, up to pressures of 100 atmospheres.

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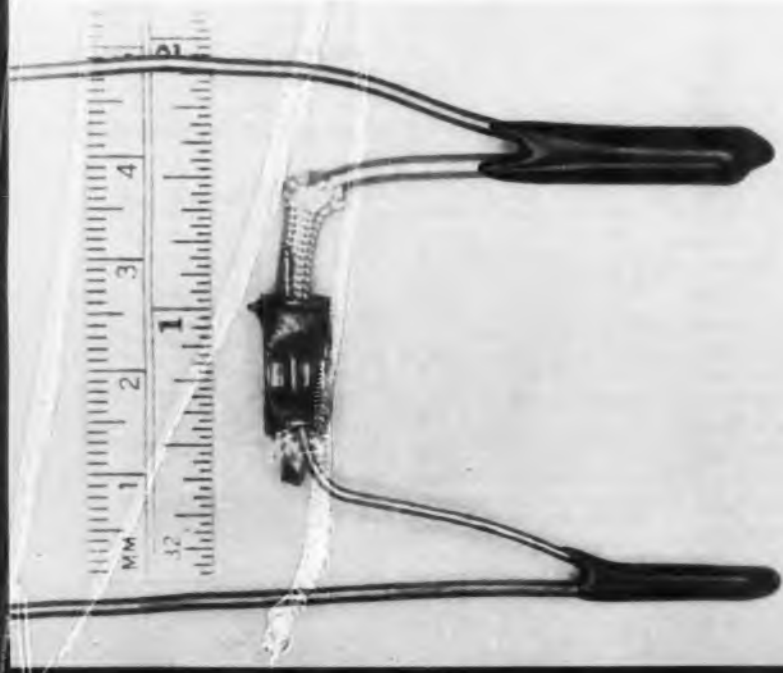
# Connectors and Galvanic Corrosion

*Many factors must be considered when predicting connector reliability. Of these, the destructive galvanic corrosion of mating metals is probably the most difficult to determine. This article presents the results of an environment simulating test which greatly aids in this determination.*

THE reliability of an electrical connection in a corrosive environment is extremely difficult to predict. First, adequate surface cleaning must occur when the joint is made. Second, the joint must be tight enough so the environment cannot penetrate and reach the metal-to-metal interface. Third, the metals used should be (by themselves) reasonably resistant to the environment. Fourth, the metals should be chosen so that destructive galvanic corrosion does not occur. It is with this last aspect that this article is concerned.

The literature on galvanic corrosion is voluminous.[1] Tables are available for estimating the probable severity of attack for two dissimilar metals in contact. In practice, many of the tables are based on the work of LaQue and Cox,[2] McKay and Worthington,[3] or Evans.[4] All of these involved actual immersion in sea water or dilute aqueous solutions.

Fig. 1: To simulate the geometry of a crimped connection, a washed fiberglass braiding is placed over the appropriate metal wire, and sleeve is crimped on top of the combination.




The extent and mechanism of attack are markedly influenced by the corrosion environment—the differences between aerated and non-aerated water, for example, are well-known.[5] Electrical contacts and connectors are rarely subjected to total immersion. It is questionable how far immersion data can be extrapolated to cover situations characterized by intermittent wetting, spray, or dampness.

Generally, corrosive situations for electrical connectors are marked by:

(a) Initially high resistance in that part of the circuit which is completed by an aqueous bridge, and

(b) Limited opportunity for removal of corrosion products.

In day-to-day practice, data are needed which will suggest to the electrical designer the suitabiliy of a particular combination in a particular environment. The ideal test

would be to use actual parts in the proposed environment for a considerable period of time. This can rarely be done. But any test should aim at simulating actual conditions as closely as possible.

Because there are both size and configuration effects,[6] the technique shown in Figs. 1 and 2 was used. It attempts to simulate the geometry of a crimped connection. A washed fiberglass braiding was placed over the appropriate metal wire, and a sleeve crimped on top of the combination. Care was exercised so that the sleeve was not crimped through the porous insulation, to insure that galvanic corrosion could not occur without current flowing through the external circuit.

Although a high humidity would be the most common environment, it was necessary to decrease the resistance of the test cell to allow a fair amount of corrosion to occur during the test period. This was done by impregnating with a 1% sodium chloride solution just prior to immersion in the environment. The initial tests were begun in 95-98% relative humidity. But the cell resistance (about 5-10,000 ohms) began to increase because the salt was being leached out. The use of a 1% salt spray was then started, and followed for all subsequent tests. A standard salt spray cabinet was used at 35°C.

### *Measuring Method*

The most direct method for measuring the actual corrosion is to intercept the corrosion current. That technique was used for this test. Here's how. The potential drop across a 10-ohm resistor (several orders of magnitude less than internal cell resistance) was fed through a stepping switch to a recorder. The switch sequentially sampled each of 48 couples in any one test. Another switch selected the proper range through a 3-step voltage dividing network. All combinations were run in duplicate; a total of 176 couples were run on electrical contact materials. Each metal was run both as wire and as sleeve.

Before discussing the individual results, it seems worthwhile to emphasize 2 points; one, that there may be design considerations other than galvanic corrosion which dictate the choice of a particular plating; two, that the results reported here for a particular type of plating might not hold for plating prepared under other conditions. Thus, nickel specimens were prepared in a standard Watts bath; there is no *a priori* reason for assuming that a sulfamate or fluoborate nickel would give exactly the same results. It is felt, however, that the results reported are strong clues as to the behavior to be expected from the metals used in electrical connectors. It is hoped that others will expand the data to include other metals and platings, and other environments.

(*Continued on following page*)

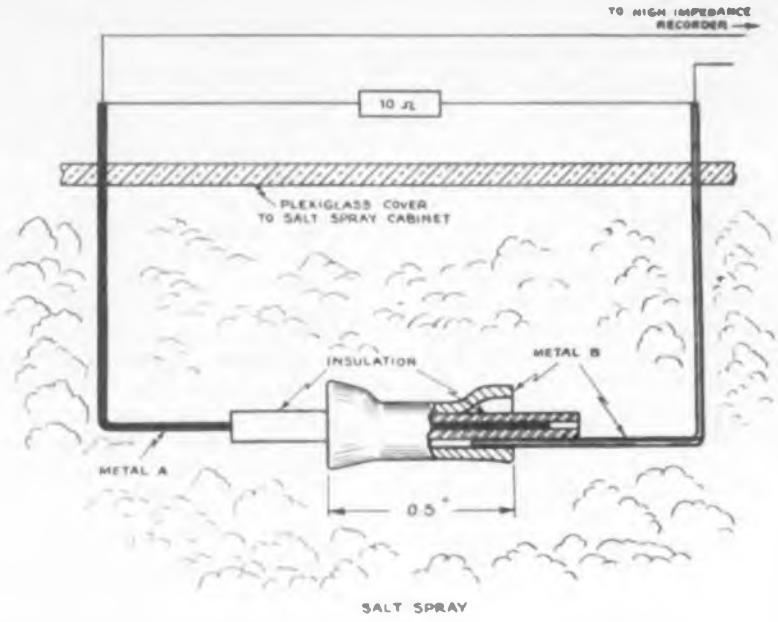



Fig. 2: **The direct method for measuring corrosion intercepts the corrosion current.**

## TABLE 1

**Performance of Various Crimped Metallic Couples in 1% Salt Spray**

**A. Completely Satisfactory Combination**
- Copper, nickel-plated copper
- Copper, gold-plated copper
- Tin-plated copper, aluminum
- Tin-plated copper, nickel-plated copper
- Tin-plated copper, solder-dipped copper
- Tin-plated brass, aluminum
- Solder-dipped copper, nickel-plated copper
- Nickel-plated copper, gold-plated copper
- Nickel-plated copper, silver-plated copper
- Gold-plated copper, silver-plated copper
- Aluminum, tin-plated aluminum (no copper undercoat)

**B. Satisfactory Combinations, Slight Galvanic Corrosion**
- Copper, silver-plated copper
- Solder-dipped copper, tin-plated aluminum
- Copper, tin-plated copper
- Copper, solder-dipped copper
- Copper, reflowed tinned copper
- Silver-plated copper, tin-plated copper
- Silver-plated copper, solder-dipped copper
- Gold-plated copper, tin-plated copper
- Aluminum, tin-plated aluminum (stannate process)

**C. Borderline, Moderate Galvanic Corrosion**
- Gold-plated copper, solder-dipped copper
- Tin-plated aluminum, nickel-plated copper
- Aluminum, solder-dipped aluminum

**D. Unsatisfactory, Severe Galvanic Corrosion**
- Aluminum, brass
- Aluminum, copper
- Tin-plated aluminum, copper
- Aluminum, nickel-plated copper
- Aluminum, nicked-plated brass
- Aluminum, silver-plated copper
- Tin-plated aluminum, silver-plated copper
- Aluminum, gold-plated copper
- Tin-plated aluminum, gold-plated copper

# Galvanic Corrosion *(Continued)*

### *Typical Test Results*

Fig. 3 is a typical test chart, showing the corrosion current which resulted from using different plated metal combinations with aluminum sleeves. The sleeves were 5050 aluminum quarter-hard. From the graphs the following conclusions can be drawn:

1. Aluminum is not passive in dilute salt spray, but corrodes rapidly.
2. Galvanic coupling of aluminum with less active metals results in large values of corrosion current. Thus gold, nickel and copper all resulted in severe corrosion.
3. While bare copper in contact with aluminum caused severe corrosion, there was little corrosion from the contact of tin-plated copper with aluminum. Tin-plating is far better in this regard than nickel, gold or silver-plating. In fact, all copper in contact with aluminum should be tin-plated.
4. The tin-aluminum couple generally appears to result in low corrosion rates, as shown by the tinned aluminum to aluminum contacts. These results are in agreement with those of Bulow and Pearlstein.[1d, 7]

### *Other Tests*

In other tests, the corrosion current for aluminum against silver-plated copper was at least as great as for aluminum against gold. Silver-plated wire generally started corroding at a low rate; silver-plated sleeves (which are bent severely during crimping) started high. This suggested that exposure of basis metal may be a factor.

Fig. 4 shows the results of similar tests in which aluminum was coupled to brass and plated brass. The same situation holds as for copper — brass against aluminum causes severe corrosion; nickel-plated brass against aluminum causes marked corrosion; while tin-plated brass results in almost no corrosion when coupled with aluminum.

One surprising result of the first test series was that aluminum, which was tin-plated by the conventional alkaline stannate process *(A.S.T.M. B253-53)*, corrodes in contact with copper at the same rate as unplated aluminum. Apparently, this type of plating is sufficiently porous or brittle to expose bare aluminum. Its use is still recommended because it gives good electrical contact properties, particularly in heat-cycling tests.[8]

Better results were obtained by using an experimental process. In this process, tin was plated directly on zinc without using an intermediate copper layer. The experimental pieces without the copper undercoat generally passivated much more quickly than the conventionally plated pieces. However, the process is still in the development stage.

The use of electroless nickel, followed by a solder dip, was also tried as possible coating for aluminum. It gave a measurable amount of corrosion when coupled to bare aluminum, and the process was not further developed.

Tests of copper against tin-plated copper and tin-plated aluminum showed that the copper-to-tin couple is actually more severe than the aluminum-to-tin couple. Since a

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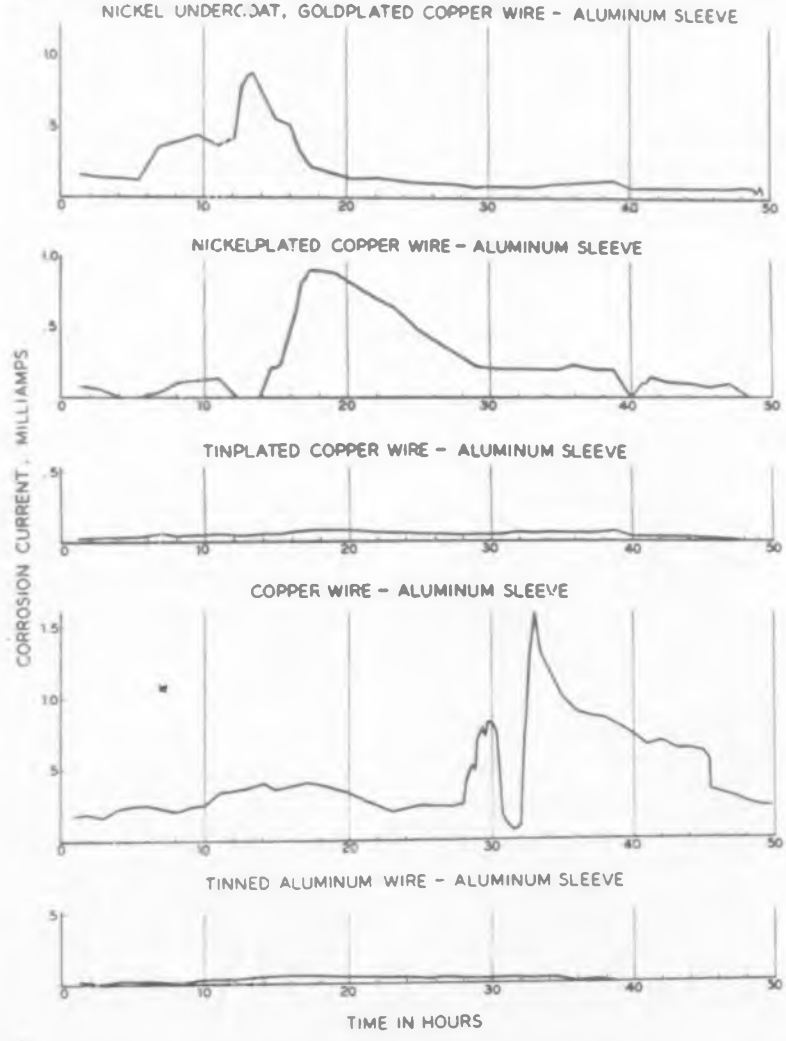
of this article can be obtained by writing on company letterhead to
The Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila. 39, Pa.

**Fig. 3: Typical test chart shows the corrosion current which results from the use of different plated metal combinations with the aluminum sleeves. Plating is above chart.**



tinned copper to bare copper connection is generally regarded as a satisfactory combination, an integrated corrosion current value of less than 0.2 ma was taken to indicate a reasonably safe combination. Integration was performed by cutting out and weighing the areas under the curves on the charts.

Results of testing copper against gold or silver-plated copper show that both of these combinations give relatively little galvanic corrosion and can be recommended in this type of environment. The copper-nickel couple appears to be entirely satisfactory. Tin-lead (solder) with copper forms a couple with about the same activity as the copper-tin couple.

Tinned and reflowed tinned copper *vs.* gold-plated copper was generally characterized by a small amount (0.02 to 0.04 ma.) of initial current, and a tapering off of corrosion current with time. No real differences were found between reflowed and non-reflowed tin-plated copper.

Corrosion currents for solder-dipped copper against silver- and gold-plated copper were about 0.1 to 0.4 ma., dropping off to very low values after 40 hours or so. For solder-dipped copper against tin-plated copper, galvanic corrosion is, as might be expected, completely insignificant. Tinplating, however, improved the performance compared to using bare copper against solder-dipped copper.

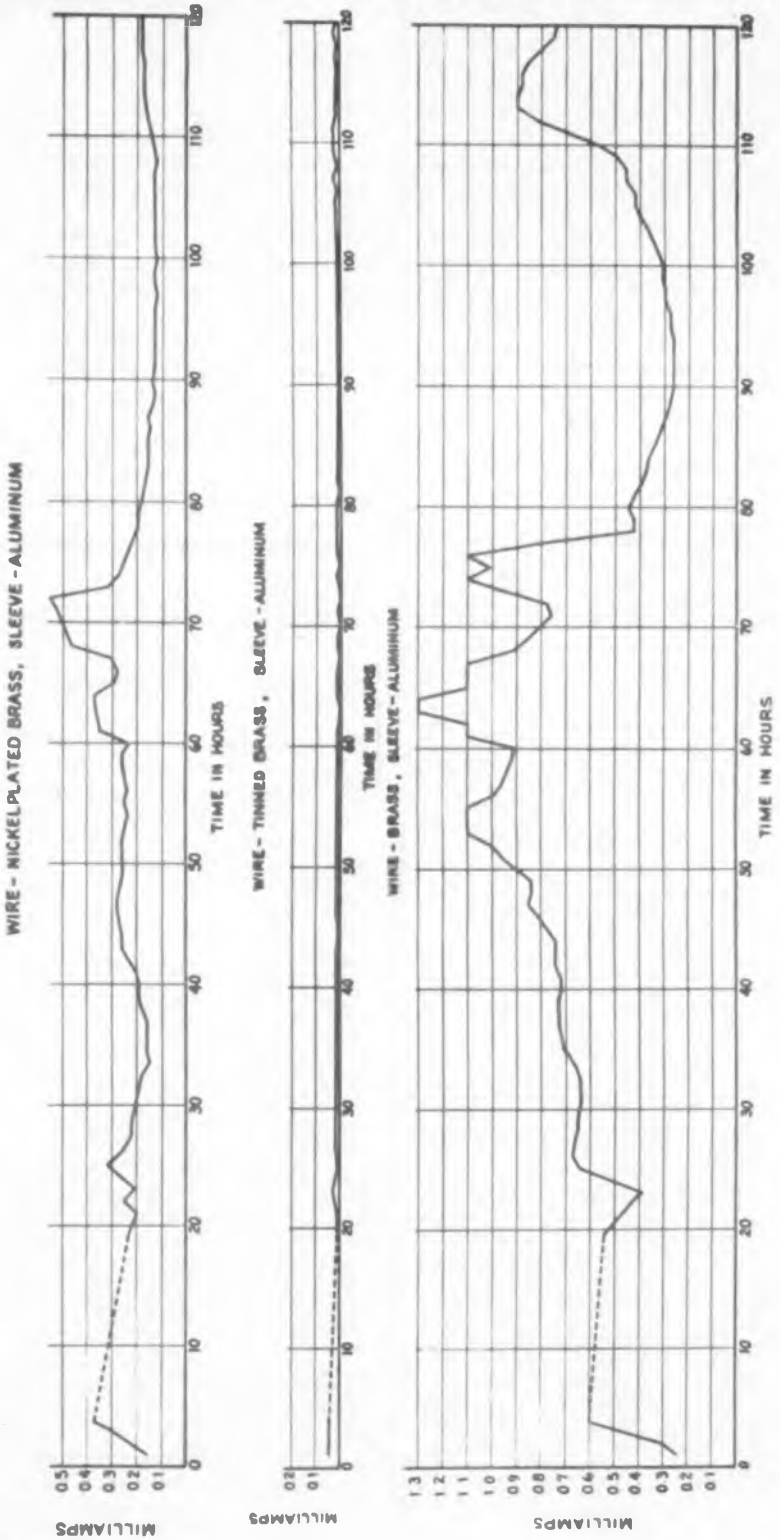
Tests of tinned *vs.* nickel-plated copper, and tinned *vs.* solder-dipped copper show that no difficulty should be encountered with either combination. While tin and nickel are a safe combination together, their behavior with aluminum was entirely different.

"Noble metal" combinations all perform well with each other in a salt-spray environment.

The data are summarized in Table 1. This is essentially a qualitative evaluation of all the individual charts. It is believed that the completely satisfactory combinations shown in Group *A* will perform well under highly adverse conditions, and that each succeeding group will be found satisfactory under still milder conditions.

(*Continued on following page*)

**Fig. 4: These charts show that the same situation holds for brass and plated brass as for copper—brass against aluminum causes severe corrosion; nickel-plated brass against aluminum causes marked corrosion; and tin-plated brass results in almost no corrosion when coupled with aluminum. Tests were similar to those used for results in Fig. 3.**



## Galvanic Corrosion

*(Concluded)*

Thus, a tinned aluminum-to-aluminum connection could be expected to show little galvanic corrosion even in prolonged outdoor exposure, while an aluminum-to-brass connection would give no difficulty in a permanently dessicated environment.


### *Acknowledgment*

A portion of the work described herein was presented at the Third E.I.A. Conference on Reliable Electrical Connections, and published in the preprints distributed in advance of that meeting.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# What's New

## Thermoelectric Efficiency Rivals Gasoline

A new thermoelectric material produces more electricity on a practical basis than can the best previously known materials.

Laboratory tests show that a generator using a plate-like arrangement of the new material with a square-foot surface heated to 1000°C could produce up to 10 kw —nearly 3 times the amount consumed at any given time in the average home.

The new material, developed by Radio Corp. of America in a research program which was initiated and largely sponsored by the USN Bureau of Ships, is an alloy of germanium and silicon. It is expected to have important military applications.

The high power density and temperature properties of the germanium-silicon alloy now open the way to a full range of compact and self-contained generators that can use:

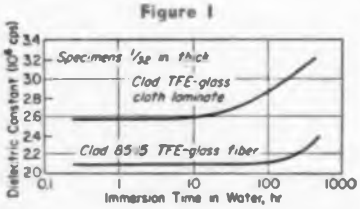
1. High-temperature nuclear heat sources to power equipment in space.

2. Solar energy to furnish elec-

## Better Dielectrics from Paper-Making

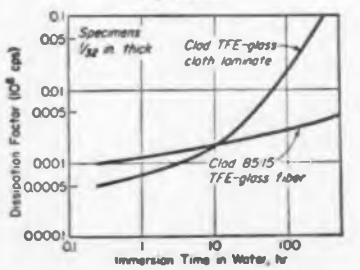
ONE of the oldest manufacturing methods—paper-making—is producing an advanced dielectric material. It is Duroid 5870, an 85:15 composite of TFE fluorocarbon resin and glass micro-fibers manufactured by Rogers Corp., Rogers, Conn.

Figure I




Effect of water immersion on dielectric constant.

Figure II




Effect of water immersion on dissipation factor.

Duroid 5870's dielectric constant is 2.30, its dissipation factor, 00.0006 at 1 MC. These values, only slightly higher than those for un-reinforced TFE, make it a close second to TFE in these critical characteristics.

But the factors that make it of even greater interest as a dielectric for microwave transmission are its abilities to retain dimension under loads and temperatures that cause changes in plain TFE. Its deformation under 1200 psi at 300°F is 0.4%; at 2000 psi, 1%. Corresponding values for TFE are 4% and 25%.

The heat distortion temperature for Duroid 5870 at 66 psi is 500°F plus; for TFE it is 250°F. At 264 psi Duroid's heat distortion temperature still remains at the 500°F plus level.

As these properties indicate, the new material couples highly acceptable dielectric properties with exceptional physical and thermal values.

Basic to the material's capabilities and its capacity to maintain them is the uniformity of its struc-

(*Continued on Page* 230)

tricity in deserts or the tropics.

3. Flame sources to power essential equipment in homes, summer camps, and even air raid shelters.

Besides its high temperature and power characteristics, the alloy is reported to offer the important added advantages of high efficiency and long life. Use of the new material in combination with lower-temperature thermoelectric materials now clears the way to silent heat-operated power packages; efficiencies will rival those of gasoline engines and other conventional generators for military, space, commercial, and domestic uses.

The new alloy has been tested by RCA scientists in units measuring only ¼ by ¼ by ½ in., but capable of producing nearly 3 watts of electricity by conversion from heat sources approaching 1000°C.

The material resulted from basic studies with specially-developed techniques to obtain the most precise measurements yet made of heat flow in semiconductor materials, of which germanium and silicon are familiar examples.

These studies disclosed that germanium-silicon alloys have far lower heat conductivity at high temperatures than had been expected on the basis of existing scientific theory. Lower heat conductivity means greater operating efficiency, since a higher percentage of the heat is put to work within the material rather than being conducted through it to be uselessly dissipated. The alloy also was found to be extremely stable even in the high temperature range — up to 1000°C. Much longer operating life can be expected than with other known materials.

The new alloy has "an ideal combination of properties" that are not present in other known materials. Among these are its thermal and electrical stability at high temperatures; high strength and durability; and a density one-third less than that of commonly-used thermoelectric materials.

RCA scientist watches test of thermocouple, made of two elements of new germanium-silicon alloy, mounted in a high-temperature laboratory heater within a vacuum chamber.

# Marking Trails Electronically

A CONVOY of trucks travels across the frozen wastelands of Antarctica. Maintaining their speed and proper distances, despite a blizzard, the convoy proceeds, without hesitation.

A small group of geologists make their way through almost impenetrable jungle. No guideposts are visible, but the party pushes ahead without deviation or detour.

These are a few of the things that can be accomplished by a new electronic system produced by the Microwave Corp. of America, Stamford, Connecticut. Called "Trailmarker," the system can lay out roads from the air; across frozen wastes; dense jungles; and timberlands. It can also be used to locate boat moorings, or to mark a trail through cleared areas of a mine field.

Of importance, from an economic standpoint, is that the Trailmarkers are built to last. They are impervious to weather conditions; are reuseable; and will operate in a temp. range varying as much as 200° F. The air-dropped units are designed to be released from 1,000 ft., land on solid rock, and still be operable.

The Trailmarker consists of passive transponders, which can be placed in a variety of locations. These are completely dormant, until activated by the transmitting-receiving equipment.

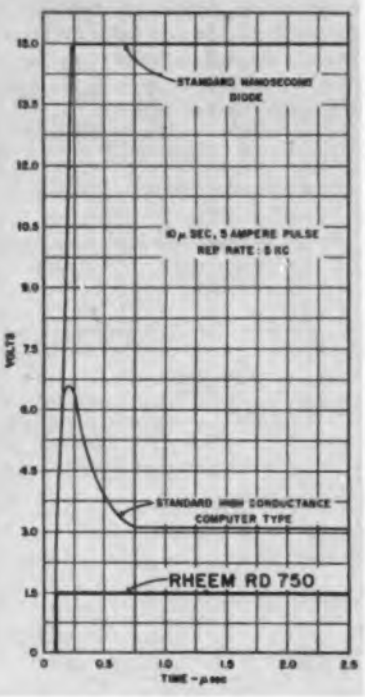
At such time as the transponders are activated by a specific signal, they absorb a portion of the power which is transmitted in the signal, and re-use this power to transmit their own characteristic signal.

The signals can be of sufficient coded variety from one transponder to another that they can be made to give a wide variety of basic information. The transceiver, consists essentially of a radio or radar transmitting system of a more or less customary type, plus

(*Continued on Page* 228)

## FAST-SWITCHING DIODE HAS HIGH CONDUCTANCE

With a conductance of 1000 ma at 1 v, Rheem Semiconductor's RD750 is said to be 5 times superior to anything previously available. This feature permits new levels of high-current switching for thin-film computer memories. The voltage drop at low current levels is about 0.65 v, at 10 ma. Power dissipation is 750 mw; this with the package size remaining unchanged from their DO-7 configuration. Reverse recovery time, 10 nano-seconds. The oscillogram at left readily shows the turn-on characteristics; a 10-usec. 5-amp square wave with a rep rate of 5 KC was used. Notice the overshoot of the others, and the difference in voltage drops. The RD750 is immediately available in unlimited quantities.



*With the advent of new, exotic devices,*
*the vacuum tube has been de-emphasized by many engineers.*
*However, tube designers are continually striving to design better tubes.*
*One area of their interest has been the heater.*
*A significant number of improvements have been made*
*in the heater over the last few years.*

## *The Materials and Shapes of*

# Vacuum Tube Heaters

**By W. A. HASSET**
*Senior Engineer*
*Western Electric Co.*
*Laureldale, Pa.*

IN vacuum receiving tubes, heat can be supplied to the cathode by either of two conventional methods: "Directly," by means of a current passed through a filament of base metal to which the emissive material has been applied; or "Indirectly," by means of a separate, insulated heating element which is mounted within the cathode structure. Because the directly heated cathode is rather simple in construction, we will discuss only the heating element in an indirectly heated cathode.

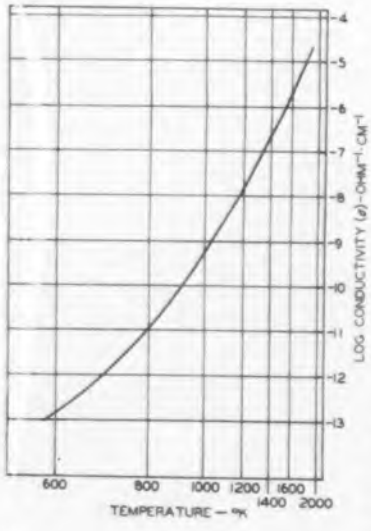



**Fig. 1: Graph shows the effect of temperature on the electrical conductivity of alumina.**

For proper cathode temperature, the heater normally operates at about 1100° to 1200° C. It may sometimes reach 1600° C in tube processing. Under these rigorous conditions, only the most carefully selected and controlled materials can be used. Therefore, the choice of heater materials is limited to those elements which are characterized by high melting point, low vapor pressure, chemical inertness and low cost. Of the available materials, tungsten, which is used as the heating element and alumina, which is used as the electrical insulating material, meet these requirements.

### *Heater Materials*

In its natural form tungsten is usually obtained from the minerals wolframite (Fe, Mn) $WO_4$ and schoelite (Ca $WO_4$). Because 70% of our original tungsten resources have been depleted, methods have been found for purifying relatively poor-grade ores.

The quality of tungsten heater wire depends upon many factors, and the materials and manufacturing process are carefully controlled. The powder used to produce the ductile metal is initially of high purity. For the purpose of inhibiting grain growth, however, very small quantities of partly volatile alkali silicates and non-volatile oxides such as silica, alumina, thoria, or calcia are added to the tungsten powder.

After being mixed, the tungsten powder is pressed into bar ingots. Ingots are then sintered at a temperature of approximately 3000° C. The time-temperature relationship at which the ingots are

sintered is carefully controlled to assure a dense bar which, in turn, determines many of the properties of the finished heater wire. At a temperature of about 1300° C, the sintered bar is worked into a rod by mechanical hammering or "swaging." During this process the cross-sectional area is reduced by 15% each time the rod is run through a successively smaller die. After the swaging process, the tungsten rods are drawn hot through a tungsten carbide die. The final, smaller wire sizes are drawn through highly polished diamond dies. As the wire is drawn and reduced in area, its tensile strength increases to as much as 500,000 lbs/sq. in.

The electrical, as well as the chemical and physical properties of tungsten have been intensively investigated. Although the resistivity of tungsten is not as high as that of some other materials, its high melting point of 3400° C makes it a desirable heater material.

At room temperature, small variations in resistivity are found among tungsten wires, depending upon their previous treatment. Despite these small variations, however, tungsten wires display similar electrical resistivities at high temperatures. This characteristic is important because it enables the mass production of reproducible heaters having a uniform current at operating voltages. No other material has such an outstanding combination of desirable properties at elevated temperatures in vacuum.

### *Alumina*

Alumina, alone or associated with silica, is a major constituent of the earth's crust. The principal alumina ore is bauxite ($Al_2O_3 \cdot 2H_2O$).

The three principal crystalline forms of alumina are designated alpha, beta, and gamma. Alpha alumina is formed at high temperatures. It is found in the natural mineral corundum and in fused alumina formed from the solidification of a melt; beta alumina is a modification containing sodium in its crystal structure; and gamma alumina is encountered in the low-temperature calcination of aluminum compounds. The alumina used for heater coating is a very high-purity alpha form.



Large fragments of the fused alumina are reduced to very fine particles by grinding in an iron-ball-mill. After particle-size reduction, the material is cleaned in acid, washed, and heat-treated to remove any contaminants. This preparation results in the pure, carefully controlled alumina particles which are important in the deposition of the alumina on the heater.

An important property of alumina, which depends upon the crystal form and purity, is its extremely low electrical conductivity. Fig. 1 shows the effect of temperature on the electrical conductivity of alumina. Thus curve represents an average based upon the work of several investigators. The thickness of the alumina coating required on a heater is a function of its dielectric strength, and usually depends upon the bias to be applied between the heater and the cathode. It is generally agreed that one mil of the coating is required for each 75 volts.

Because heat energy is primarily transferred from the heater to the cathode by radiation, the thermal conductivity of alumina, although good, is not too important a factor. The chemical stability, high melting point, and electrical resistivity are the important properties that make alumina a dependable insulating coat for vacuum tube heaters.

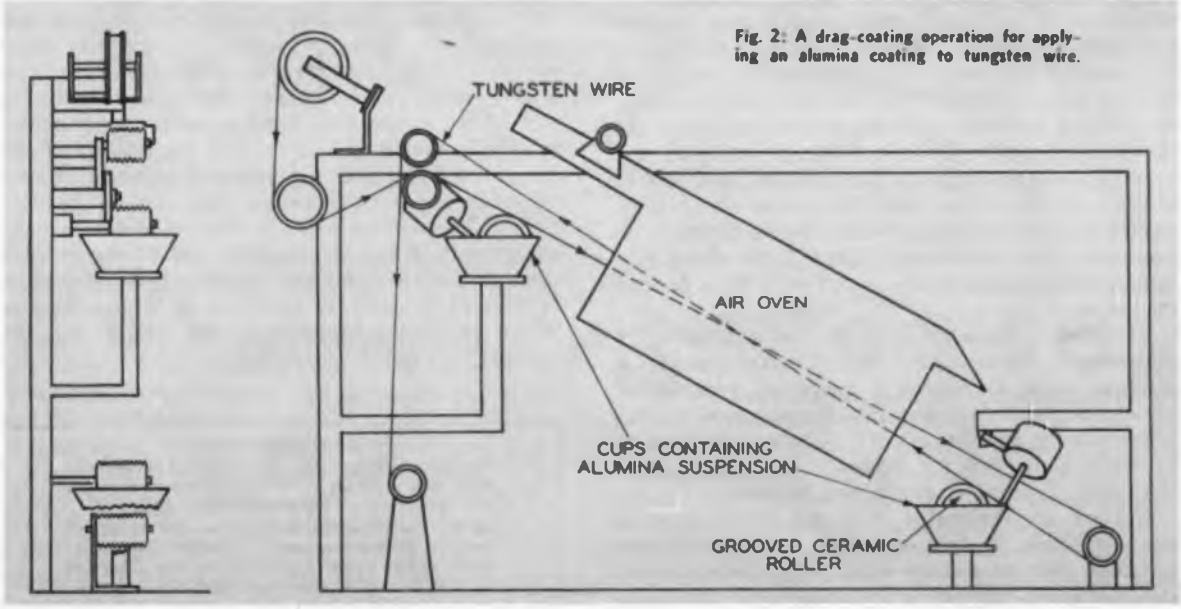



Fig. 2: A drag-coating operation for applying an alumina coating to tungsten wire.

# Tube Heaters *(Continued)*

### *Methods of Alumina Deposition*

One technique used for the application of the alumina insulating layer to the tungsten wire is the "drag"-coat method. As the name implies, the bare tungsten wire is passed or dragged through a specially prepared alumina suspension. This suspension is composed of a very pure, fused and milled alumina in a solution of methanol, aluminum nitrate salt, and distilled water. The alumina particle size usually ranges from 5 microns to 40 microns. The methanol acts as a suspending agent for the fine alumina particles and evaporates quickly as the wire passes from the suspension into an air furnace. The aluminum nitrate salt acts as a low-temperature binder. It cements the alumina particles together as each layer is built up during the "drag" operation.

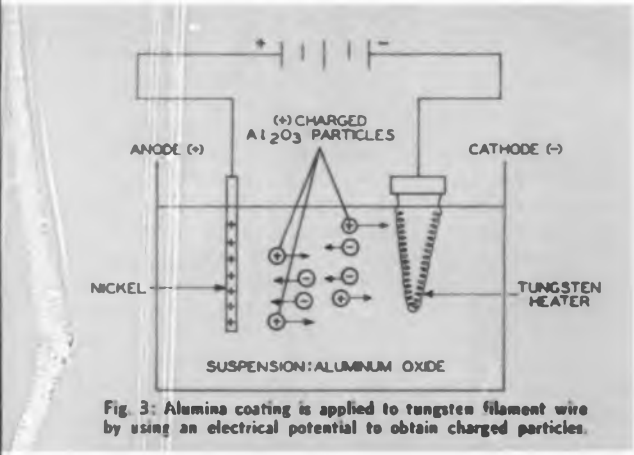



**Fig. 3: Alumina coating is applied to tungsten filament wire by using an electrical potential to obtain charged particles.**

Fig. 2 is a sketch of the "drag"-coating operation. The grooved ceramic roller rotates partially submerged in the alumina suspension, and applies a thin layer of coating to the tungsten wire passing over it. The specific gravity of the suspension and the speed of the machine are adjusted so that after 8 or 10 passes of the wire over the ceramic roller, the coating is built up to the desired diameter. As the wire leaves the ceramic roller, it enters an air oven. Oven temperature is between 600° and 800° C to dry and bake the coating. The coated wire is then passed through a hydrogen-atmosphere furnace. It operates at approximately 1200° C to chemically reduce any tungstic oxide which may have formed on the wire.

The coated diameter is controlled automatically by means of a photoelectric cell. The cell operates a solenoid valve to release a measured quantity of aluminum nitrate solution into the suspension, thus adjusting its specific gravity. The coated wire is carefully controlled for diameter, smoothness, concentricity, flexural strength, and weight.

Heaters are fabricated from the coated wire by spade-winding. In this operation, a length of wire is folded over razor-sharp edges set a predetermined distance apart, depending upon the linear dimension of each heater strand. After the proper number of strands are wound, the heater is automatically cut from the continuous length of spooled wire. Simultaneously, a small section of the coating is removed from the heater legs to expose the wire at the ends for welding to the tube stem leads.

### *Cataphoretic Coating*

Cataphoresis or electrophoresis is defined as "the migration of coloidal particles under the influence of an electrical potential." Cataphoresis, as applied to heater coatings, is the process by which positively charged alumina particles are deposited on a negatively charged tungsten heater wire. The alumina used in the suspension consists of very fine particles, usually in the one-to-five-micron size range. An increased number of ionized groups on the alumina surface results when the particles are surface-charged by the addition of small amounts of selected soluble inorganic salts, such as aluminum nitrate.

The charge and stability of the alumina particle in the suspension is due to the preferential absorption of a particular ion. By the application of a potential, the positively charged alumina particles are deposited on the negatively charged tungsten heater, and a layer of alumina is built up to form the insulating coating. Fig. 3 illustrates the deposition of alumina on a heater. Generally, the amount of alumina deposited on the wire depends upon the mobility of the particles, the concentration of the particles in the suspension, and the potential between the anode and the cathode. In production, a clip holds a number of heaters, which are submerged in a suitable alumina suspension, while a fixed voltage is applied. The coating thickness depends upon the value and the duration of this voltage. After the heater is coated, it is sintered at 1600° C for a short time in a hydrogen-atmosphere furnace.

### *Spray Coating*

Heater coatings are also applied by the spray technique. As in the drag and cataphoretic coat suspensions, the spray suspension is specially compounded for optimum results. High-quality spraying is obtained by control of the viscosity and the drying rate of the suspension. Organic solvents are added to aid dispersion and to prevent the settling of the fine-grained alumina. A nitrocellulose binder is used to produce a tough coating that can be handled easily. The desired coating texture is obtained by adjustment of the air pressure and of the area of the orifice of the spray gun. A smooth, dense coating is desired because it produces a strong coating which facilitates insertion of the heater into the cathode during tube mounting.

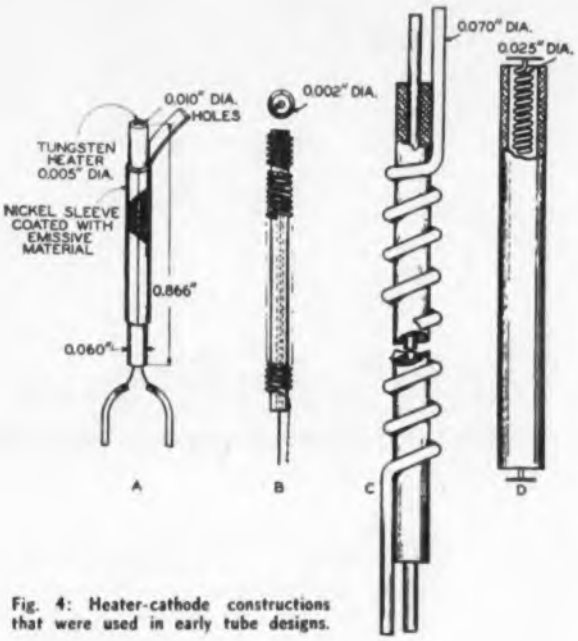



Fig. 4: Heater-cathode constructions that were used in early tube designs.

The heaters are mounted into a clip. The clip is placed in a rotary spraying machine having spray guns positioned at selected points. At each revolution, the sprayed alumina is deposited in thin layers which are dried by infrared lamps. The desired coating weight and thickness are obtained after several revolutions of the coating machine. For sintering of alumina, the heater is fired at 1600° C in a hydrogen atmosphere furnace.

### *Heater Configurations*

Heater designs have varied considerably since 1927 when the first indirectly heated cathodes were introduced. At that time, a hairpin tungsten heater was supported by an extruded ceramic insulator, surrounded by a nickel sleeve. Fig. 4a shows a heater common to the early detector- and amplifier-type tubes. This heater operated from a 2.5 volt supply. It had a warm-up time of 20 to 30 seconds. Fig. 4b shows a 2 mil wire spirally wound on an alumina insulating tube. The return lead passed through the center of the insulating rod. Usually the wire was covered with an outside alumina coating.

Fig. 4c illustrates a 70 mil diameter tungsten wire wound around an alumina insulator. A molybdenum rod passing through the center of the tube acts as a support rod. Such heaters were designed to operate at 5 volts and 60 amperes. Fig. 4d shows a 25 mil diameter spiral heater wire supported inside an extruded insulating tube.

All of these heaters were made in various sizes to meet different heater-power requirements. The ceramic insulating sleeves were usually made of alumina, magnesia, thoria, beryllia, or electrical porcelain. Many factors, such as high cost, contaminants in the ceramics, and slow warm-up time, resulted in the decline of these heaters.

A few of the heater designs now in use are briefly described in the following section. The basic designs fall into the following three groups: the spade-wound folded heater, the single helical heater, and the double helical heater.

### *Folded Heater*

The folded heater, made from drag-coated wire, is simple and easily manufactured. There are many design modifications in this type of heater. However, three principal forms are the staggered apex, the straight apex, and the sloped apex. The staggered-apex type is designed so that each succeeding fold is shorter than the other; the straight-apex type has each apex opposite another; and the sloped-apex type has the top and bottom apices sloped parallel to each other.

The staggered-apex heater, shown in Fig. 5a, is mostly used in round cathodes requiring a closely-packed heater. In such an arrangement, the shorter apices nest between the strands of the longer apices, thus preventing their direct contact. The straight-apex heater is best suited for a flat cathode whose cross-sectional area permits a certain amount of alignment of the heater strands, and permits the apices to spread. Because the folded heater is versatile, it is used in either round or flat cathodes. The choice of strands is determined primarily by the fit of the heater within the cathode. In practice, the folded heater is commonly used in octal tubes of the rectifier type and the power amplifiers. The heaters used in these tubes are of extremely rugged construction, and they typify the design of most of the spade-wound heaters.

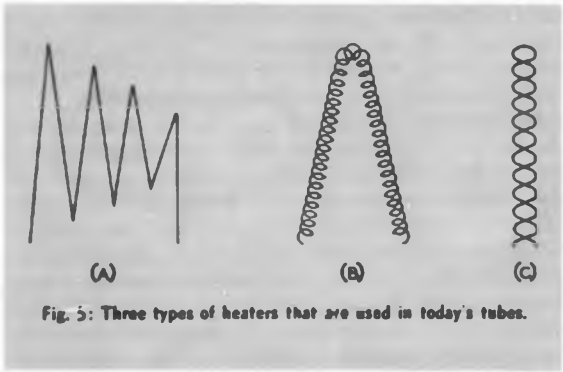



Fig. 5: Three types of heaters that are used in today's tubes.

### *Single Helical Heaters*

The three single-helical shapes commonly employed in vacuum tubes are the inverted "V," or hairpin, the inverted "U," and the "M" shape. The "V," or hairpin shape, is used to accommodate single cathodes, whereas the inverted "U" or "M" shapes are used to accommodate 2 cathodes, depending upon whether the heater bridge between the cathodes is at the top or bottom of the tube cage construction. These heaters are made by winding tungsten wire around a metal mandrel to form a helix. Helix is cut to the acquired length and bent into the desired shape. Because the heater current depends upon

## Tube Heaters *(Concluded)*

the total wire length rather than the helix length, the turns of wire are precisely spaced so that each heater is accurately reproduced. After the heater is formed, it is cataphoretically coated with alumina and sintered at a high temperature in a hydrogen atmosphere. The core, usually molybdenum, is removed by an acid-dissolving process.

Because the extremely high number of turns per inch obtainable with this heater permits more wire per unit length, it is possible to use a single helical heater in thirty-mil-or-less flat or round cathodes which normally would require tightly packed folded heaters. Fig. 5b illustrates a single helical hairpin heater, the most popular shape of the helical heaters. It is used extensively for minature tubes in which power requirements dictate heater designs involving long wire lengths.

### *Double-Helical Heaters*

Use of the double-helical heater is usually restricted to round cathodes having diameters of 30 mils or larger because the mechanical forming techniques make it difficult to make smaller sizes. The heater wire is cut to the desired length, fed into a coil-winding machine, and wound around a mandrel. After the coil is removed from the mandrel, the alumina insulating layer is applied by spray or cataphoretic coating techniques. To increase the amount or wire in a double-helical heater, a single helix wire is frequently shaped into a double-helical heater by winding on a mandrel. This modified design not only permits a greater length of wire to be placed in the cathode, but also takes advantage of low hum characteristics of the double-helical heater. Fig. 5c shows a double-helical heater used in octal or miniature tubes requiring low hum characteristics.

Of the many complicating factors that enter into the design of a heater, such as the relative emissivities of the heater and inner surfaces of the cathode, the thickness of the heater coating, and the heater fit within the cathode, the dimension of the cathode sleeve is of prime importance. This dimension determines the heat that the heater must furnish to maintain the proper cathode temperature. The heater design temperature is calculated from the appropriate tungsten resistivity formulas or determined from nomographs specially constructed for the purpose.

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**By JOHN E. HICKEY, Jr.**
*Associate Editor*
*ELECTRONIC INDUSTRIES*


# Nuclear Blasts

THE editors of *Electronic Industries* are concerned over the possible effects of a nuclear blast outside of the blast zone. We mentioned this in our September Editorial, "We Need Nuclear Test Facilities & Standards."

After publishing this editorial we received a deluge of letters, some saying that we were right, and some saying that we were wrong. Armed with the information contained in these letters we contacted many people active in the nuclear testing field. From discussions with these people we learned many things, such as the following.

In the past the only threat to electronic equipment was thought to be in the blast or heat areas. It was felt that for equipment to be destroyed by radiation doses, it had to be in these areas. Recent experiments have shown this to be far from true.

Equipment 100 miles or more away from the blast will feel the effects of radiation doses. While the total radiation dosage of high intensity pulses is negligible, and with a magnitude less than that which would permanently destroy equipment, it can cause many types of equipment to malfunction. (The malfunction is caused by transients created in the equipment by the radiation pulse.) For instance, a process computer could be made to react erroneously by a burst of radiation, missiles could be sent to the wrong target, vital communications can be disrupted, and aircraft might experience loss of control. Early reports indicate that the more sophisticated the equipment or system, the more vulnerable it is to radiation doses.

These strange effects and reactions can be caused by a pulse 80-100 microseconds wide, giving a dose rate of $10^4$-$10^7$ roentgens per second. These dose rates will exist tens—or even hundreds—of miles from a nuclear

*Electronic equipment and systems can be effected by nuclear radiation pulses at a long distance from a blast area. While these pulses may not permanently disable the equipment, they do cause a temporary "failure." Pulses can make a missile head for the wrong target, disrupt vital communications or upset a process control computer.*

# and Unreliability

blast, well beyond the distances at which blast and heat effects are considered important. This effectively increases, tremendously, the enemy's kill range of our weapons and systems.

Some immediate suggested remedies are: to use inorganic materials—they appear to have better recovery characteristics than organic materials; select radiation resistant components; favor analog circuits over digital circuits; use low-impedance circuits to reduce the amount of induced conductivity; and place the most susceptible components in the center of equipment packages. Indications are that high temperature circuits should be tolerant to radiation pulses. This is based on the assumption that high temperatures create low resistances in most materials and, therefore, high temperature circuits cannot be very high impedance circuits.

As we just mentioned, most of this can be eliminated by the proper selection of materials, components, circuitry, and proper packaging of our equipment. However, to most effectively accomplish this, we must have more knowledge of the behavior of these items under nuclear radiation pulse conditions. This means that there must be more testing in these areas. To date, most of the testing has been on a small scale and scattered. Also, the findings of these tests must be widely disseminated so that corrective action may be taken. (This last sentence will sound familiar to reliability engineers. It should, because nuclear failure will have to be a facet of any reliability program.)

Presently good nuclear standards are not in existence. This is a situation which must be remedied. Much of the work being done is by a limited number of researchers. Some of the work is by private companies and some by government agencies. Unfortunately, not on the magnitude required during these times.

At present, the most active step we, the editors, can take is to disseminate information to you, our readers. Electronic engineers must be equipped with the information to accomplish the necessary corrective action. To properly achieve this end, we formulated an outline for a series of four articles. These articles are in-

(*Continued on page* 231)

## REACTOR FACILITIES

**Here is a list of reactors and proposed reactors known to us. In most cases these reactors are not being used anywhere near their full capabilities.**

### Operating Reactors

Argonne Research Reactor—Lamont, Ill.
Armour Research Reactor—Chicago, Ill.
Battelle Research Reactor—Columbus, Ohio
Brookhaven Medical Reactor—Long Island, N. Y.
Brookhaven Neutron Source—Long Island, N. Y.
Brookhaven Research Reactor—Long Island, N. Y.
Bulk Shielding Facility—Oak Ridge, Tenn.
Curtiss-Wright Research Reactor—Quehanna, Pa.
Engineering Test Reactor—Oak Ridge, Tenn.
Ford Nuclear Reactor—Ann Arbor, Mich.
G. E. Nuclear Test Reactor—Vallecitos, Calif.
G. E. Test Reactor—Vallecitos, Calif.
Georgia Nuclear Labs. Reactor—Dawsonville, Ga.
Godiva II (pulse)—Los Alamos, Calif.
Ground Test Reactor—Ft. Worth, Texas
Hanford Reactors—Richland, Wash.
Kukla (pulse)—Livermore, N. Y.
Industrial Reactor Laboratories—Plainsboro, N. J.
Livermore Pool Type Reactor—Livermore, N. Y.
Livermore Water Boiler—Livermore, N. Y.
Low-Intensity Testing Reactor—Oak Ridge, Tenn.
M. I. T. Research Reactor—Cambridge, Mass.
Materials Testing Reactor—Idaho
NAA Water-Boiler Neutron Source—Santa Susanna, Calif.
Naval Research Reactor—Washington, D. C.
Oak Ridge Graphite Reactor—Oak Ridge, Tenn.
Oak Ridge Research Reactor—Oak Ridge, Tenn.
Omega West Reactor—Los Alamos, N. M.
Pennsylvania State Univ. Research Reactor—University Park, Pa.
Raleigh Reactor—University of N. C.
SPRF (pulse)—Sandia Base, Albuquerque, N. M.
Thermal Test Reactor—Savannah River, S. C.
Triga (pulse)—San Diego, Calif.
Westinghouse Test Reactor—Waltz Mill, Pa.

### Research Reactors Under Construction

Air Force Nuclear Engineering Test Reactor—Dayton, Ohio
Cornell University Nuclear Reactor—Ithaca, N. Y.
NASA Research Reactor—Sandusky, Ohio
Sandia Engineering Reactor Facility—Albuquerque, N. M.
Texas A & M Research Reactor—College Station, Texas
University of Buffalo Research Reactor—Buffalo, N. Y.
University of Virginia Reactor—Charlottesville, Va.

### Research Reactors Being Planned

Georgia Institute of Tech. Research Reactor—Atlanta, Ga.
High-Flux-Beam Research Reactor—Brookhaven, Long Island, N. Y.

For more information about reactors and their locations, see "Nuclear Reactors, Built, Being Built, and Planned," TID-8200, 4th revison, June 30, 1961. Copies may still be available from the Atomic Energy Commission, P. O. Box 62, Oak Ridge, Tenn.

Compiled with the assistance of J. R. Crittenden, General Electric Co., Owensboro, Ky.

By JAMES C. KYLE
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J. C. Kyle


L. E. Baird

# Insulating Against

EXCELSIOR—ever upward—that often used word of Latin origin, can well be applied today. Applied to the ever-growing insulation material needs of space technology and atomic-nuclear engineering.

After years of trial and study of silicon and ceramic compounds, and the subsequent proof of their practicability in 3 product groups: (1) electrical connectors, headers; (2) magnet wire coating; and (3) potting/encapsulation, we have established 22 proprietary formulations under the general title of PSC-Durock. Using bead insulators, Fig. 1, of this material, electrical connectors can pass an electrical circuit through a bulkhead at 180 v., under a pressure of 10,000 psi, at a short-term temperature of 1200°F and/or 850°F continuous for 10,000 hours, within a nuclear reactor environment, holding a high vacuum seal at the rate of $2 \times 10^{-10}$ and at the same time be resistant to corrosive fluids.

### *Silico-Ceramic Compounds*

While the combination of the above in one installation is indeed rare, this new silico-ceramic insulation material has met just such combined specifications in a variety of applications.

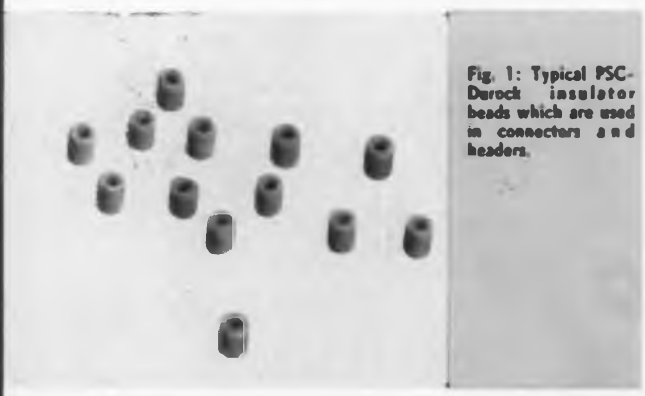
Fig. 1: Typical PSC-Durock insulator beads which are used in connectors and headers.

Perhaps the most striking example of the performance of these materials can be found in the nuclear field. Specifically, a creep capsule monitor system designed and built for the Hanford, Wash., facility of the Atomic Energy Commission which is operated by General Electric. This system has run up a record of 21,000 hours continuous operation. Without this particular insulation material, it is doubtful that the capsule could have operated continuously for more than 100 hours.

In the AEC/GE capsule, Fig. 2, the silico-ceramic insulation is used to provide a vacuum seal for the penetration seals located on one end of the capsule within the reactor. Durock coated magnet wire is used to wind the coils of various transducers (sensors) employed to measure creep (movement) pressure and temperature. The micro-positioner contact uses silico-ceramic insulator beads. Signal lead wires, thermocouple wire, heater hook-up wires and the extension cabling are also insulated with the material.

During the 21,000 hours, the insulated components maintained their integrity at temperatures from 800°F to 850°F with satisfactory operating reliability—a "first" in the nuclear field.

### *Comparable Materials*

For many years glass has been, and still is, used as the insulating dielectric for hermetically sealed connectors and headers. At least 2 varieties are commonly produced; one broadly classified as a low compression seal and the other as a high compression seal.

The primary means of providing vacuum integrity is a mechanical force exerted between the glass insulator and the surrounding wall and pin. In the design of such seals, it is important to maintain large values of hoop stress throughout the temperature range to which the seal will be subjected. This pre-

*Higher temperatures are always in demand; nuclear resistance often a must. Here are some of the new compounds which meet these requirements.*

# Nuclear Effects

vents loss of mechanical bond, and, therefore, vacuum integrity.

Many limiting factors, however, prevent the use of glass in either high temperature or severe nuclear radiation environment. At temperatures above 425°F, glass, or glass-like amorphous materials, tend to become semi-conductors. This is a result of the inherent alkali structure, with the inherent alkaline ion mobility resulting in a complete loss of insulation properties at temperatures much higher than 500°F. As the temperatures increase, the large hoop stresses necessary for satisfactory vacuum integrity present severe mechanical limitations.These are due to the metal structure's inherent creep properties which are greatly accelerated by increasing the environmental temperature. Therefore, vacuum tight seals depending on high hoop stress (compression seals) are useful for very limited periods of time at elevated temperatures.

However, the most severe limitation of conventional sealing glass exists when subjected to extreme radiation environment. It is here that the conventional glass formers present problems associated with radiation damage. The radiation damage effect is primarily a mechanical phenomena—a change in the molecular structure causing a physical change in dimension, sometimes referred to as a swell phenomena. Perhaps the most severe effect is noticed in the boron family complex. The presence of minute quantities of boron will result in complete physical failure within a relatively few hours of radiation. Many other elements commonly required as glass formers are also quite subject to radiation damage. In summary, a brief inspection of the amorphous materials results in a rather hopeless picture for this family.

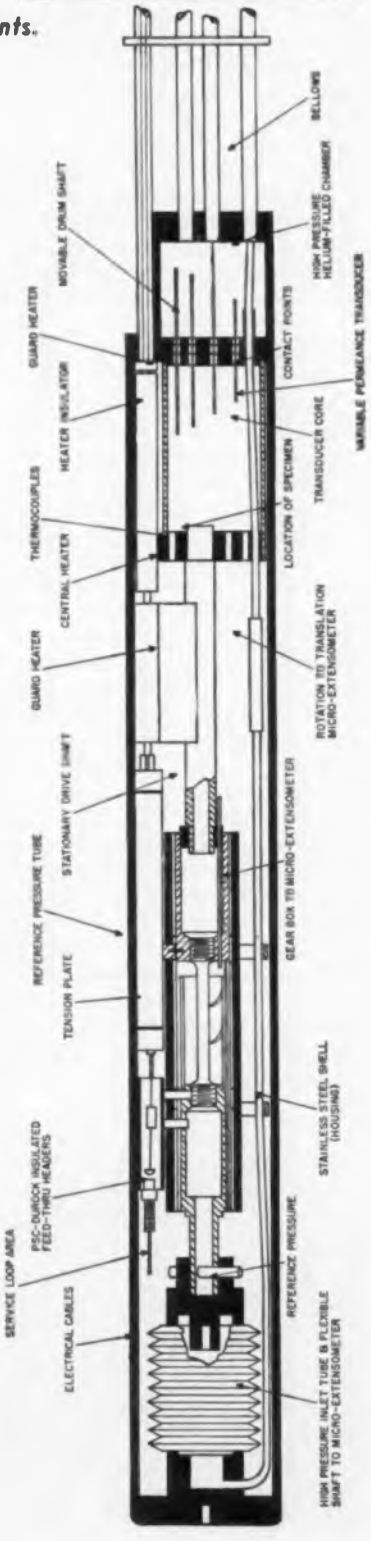


Fig. 2: In this Atomic Energy Commission—General Electric Company creep capsule, silico-ceramic insulation is used extensively for seals, wire coating, and insulator beads.

### *Alumina*

Although the use of ceramics, e.g., alumina, in lieu of glass for high temperature, high vacuum seals has

been in common practice for a number of years, similar limitations exist if we examine the common metalized family of ceramic vacuum seals. Perhaps the most severe limitation again is found in the presence of nuclear radiation. Here the combined effect of temperature, produced by gamma heating, and radiation damage result in physical changes. This occurs mainly in the interfacial bond resulting in loss of vacuum integrity within brief time histories.

Although ceramics can maintain their physical integrity in the presence of high temperature and radiation, their use is dependent upon the development of a ceramic type that provides interfacial bond directly to the associated metal structure without large hoop stress (compression). Further, it must not introduce into this interfacial area metallic complexes known to be subject to radiation effects. Obviously, the requirement of a ceramic chemical bond to high temperature metal alloys was a dominant requirement in the development of our silico-ceramic material.

Our ceramic insulation compounds are best suited to various metals for shells and contacts which metals are satisfactory for high temperature and severe radiation service. These metals include Inconel, Inconel "X," the #300 and #400 stainless steels, PH steel, super alloys, Hasteloy, Titanium, Zircalloy, and coatings for aluminum, aluminum-clad copper, nickel-clad silver wire and thermo-electric alloys such as constantan, chromel and alumel.

When properly matched, these materials assure a vacuum integrity of $2 \times 10^{-9}$ standard cc He/sec. of helium at 800°F. This vacuum integrity is also maintained in a radiation environment for a period of 20,000 hours, resulting in a combined total integrated flux of $1 \times 10^{20}$ NVT. This represents the best vacuum pressure integrity so far developed.

To achieve the above performance parameters it was necessary to arrive at reliability parameters of 99.995 at 95% confidence. This reliability parameter was achieved only after the careful evaluation of more than 200,000 components which had been subjected to artificial aging.

### *Reliability Test*

A typical ultra-high reliability test is as follows:

(1) Parts are simultaneously heated to 700°F for 30 minutes in a conventional air atmosphere. The parts are removed from the furnace and quenched in liquid nitrogen at −325°F for 5 minutes, and then returned to room temperature for 5 minutes.



Fig. 3: Four formulations of silico-ceramic compounds are specially made for the coating of magnet wire with this piece of machinery.

(2) The parts are again placed in a furnace and heated to 700°F for 30 minutes, after which they are removed and quenched in tap water at 70°F ± 20°F for 10 minutes.

(3) After being taken out of the tap water and allowed to adjust to room temperature, they are set aside for a minimum of 24 hours. Following the completion of this stage, they are re-tested for vacuum integrity, $2 \times 10^{-9}$ cc He/sec. on a mass spectrometer. A minimum leak resistance of 200,000 megohms at 1000 VDC is also measured.

Many formulations can be used in nuclear service. The coefficient of resistivity ranges from $1 \times 10^{12}$ ohm/cm to $1 \times 10^{15}$ at 70°F. At 600°F, $1 \times 10^{17}$ ohm/cm to $1 \times 10^{7}$ ohm/cm; at 1200°F, $1 \times 10^{15}$ to $1 \times 10^{3}$ ohm/cm; at 1600°F, $1 \times 10^{10}$ ohm/cm; and at 2000°F, $4 \times 10^{5}$ ohm/cm.

The top maximum operating temperature is 2100°F for 1 hour. Longest maximum operating temperature is 10,000 hours at 1800°F; next highest, at 1650°F for the same period. Greatest compressive strength is 41,000 psi, with a modulus of rupture at 21,000 psi.

### *Magnet Wire and Cable*

Four formulations are specially made for the coating of magnet wire, Fig. 3. Like the insulator beads used in connectors, the silico-ceramic insulation effects a chemical bond and enables the wire to withstand extreme environments.

The coated aluminum wire is rated at 1000°F for 1000 hours; 20,000 hours at 800°F. In a nuclear environment having a cross-section capture, absorption is 4.6 barns; scatter, 16.20 barns. The insulation coating ranges from 0.0003 in. to 0.0005 in. Hydroscopicity is 0.007%.

Other coated wire types are aluminum-clad copper, nickel-clad copper and nickel-clad silver.

### *Potting and Encapsulation*

The potting/encapsulation formulations compounded from the same general silico-ceramic materials pro-

vide protection of instruments and components against shock; vibration and moisture at high temperatures; and, within nuclear environments of varying degree. These include transformers, chokes, transducers and other assemblies having coils. The formulations can also be used as exhaust and nose cone lining material.

The long-term temperature ratings range from 2000°F to 3500°F; short term 2400°F to 4000°F. Nuclear resistance is rated in barns cross-section capture; absorption 0.0349 to 0.0609; scatter 16.8 to 22.4. Nuclear flux rating, mixed field, 6000 hour test is $1 \times 10^{13}$.

Shrinkage during cure is 1.5% to 2% and pot life within the maximum characteristics, is more than 5 years.

Mixing, applying and curing of these silico-ceramic potting compounds require care in following designated procedures. The application is generally made in thin layers, baked at 150°F for 2 hours, then at 600°F for 4 hours. A complete cure can be effected through baking at 1000°F for one hour. The purpose of these high temperatures is to de-gas the compound.

One compound is pre-mixed and can be completely curd at 500°F for 6 hours.

The addition of the hardener to the mix which lowers the temperaturee maximum but provides adhesive qualities where needed, is also desirable for the jacketing of soft coils, and seals of non-critical type.

A glaze compound is available where maximum hardness is needed and/or good moisture-proofing. A liquid, the glaze can be mixed with the powder without mixing with water or hardener.

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# Extend Range Of Crystal Filters

NEWLY developed technologies for stable piezoelectric ceramic band pass ladder filters will make possible an extension of the 455 KC frequency range by an order of magnitude. This is the claim of D. R. Curran and D. J. Koneval, Electronic Research Division, Clevite Corp., Cleveland, Ohio, at the 17th Annual National Electronics Conference.

These technological advances result from a 3-year program to improve piezoelectric materials and design applications. Desirable temperature and aging characteristics are obtained by using an advanced piezoelectric formulation of a lead zirconate-lead titanate ceramic developed by Clevite. Thin discs of this material with electroded faces, poled in the thickness direction, have characteristic frequencies stable to within 0.1% with temperatures ranging from —40° to + 85° C. and within 0.1% per decade of time.

Choice of the type of resonator and its mode of vibration are dictated by the center frequency desired in the resultant filter. The radial modes of vibration are strong, inherently free from spurious responses and as a result are used wherever possible.

The experimental ceramic filter package is rugged, reliable, and compact. Mechanical support and electrical contact of the individual filter components within the package are achieved with pressure contacts. These are preferred over soldered contacts since they do not tend to become part of the vibrating element and thus avoid termination problems.

A novel approach to ceramic filter design at higher frequencies uses the Uni-Wafer filter, wherein discrete portions of a ceramic wafer can be activated independently to form a complete ladder filter within a single "two-dimensional" structure. The experimental ladder filter assembly contains as many as 20 individual ceramic filter discs. Typical complete assemblies are only 0.31 x 0.31 x 0.28 in. and weigh only 0.1 ounce. Experimental Uni-Wafer T-sections have been fabricated in the 10.00 MC frequency range with less than 2 db minimum insertion loss and with band widths from 3 to 5%.

**Here's how the experimental ladder filters are assembled. They were developed for the 1 to 8 MC range and they simplify circuitry.**

Ed.: For a more thorough treatment of this subject see "Ceramic Filters Aid Miniaturization," *Electronic Industries*, Nov. 1959, pp. 106-109.

*A Simpler Approach to . . .*

# Junction Transistor Analysis for Circuitry

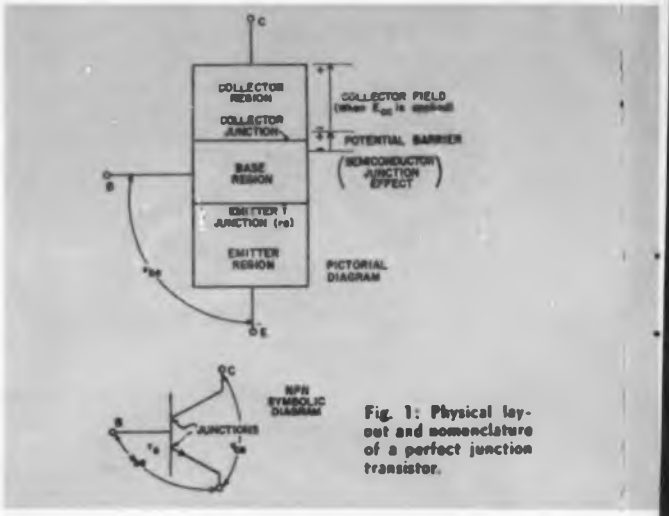


Fig. 1: Physical layout and nomenclature of a perfect junction transistor.

Part One of Two Parts

*A rigorous mathematical-physics analysis has become traditional in most texts dealing with transistors. This method can be cumbersome, while granting little intuition for the subject. Here is a new and simpler approach that can be applied to the design and development of circuitry.*


**By JAY ENGLEMAN**

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THE discovery of the transistor by physicists led to its presentation in a formal, and academic approach. Although most recent texts have minimized the physics considerably, the rigorous mathematical analysis has become traditional. Even texts for beginners, either oversimplify or merely reduce details while explicitly following the formal atomic physics approach. These foregoing methods provide for academic learning but unfortunately omit the insight that leads to increased confidence in the circuit designer.

The purpose of this article is to attain that insight by using a new and simpler approach to illustrate the properties of the transistor as applied to the design and development of circuitry. The tone of this paper is, therefore, not academic. It follows lines of straightforward reasoning.

Experience gained in vacuum tube circuitry has some value when applied to circuitry using transistors. However, it is debatable whether any comparisons between tubes and transistors can actually provide an advantage. Therefore, similarities or differences between the two devices has been omitted from this paper and the transistor is treated specifically and as an independent tool.

Part 1 provides an idealized foundation for this article's idea which can also serve as a transistor introduction for sales engineers and engineering technicians.

Part 2 analyses and develops the characteristic properties of a transistor from a practical design standpoint.

### *The Perfect Transistor*

First the operation of a perfect transistor will be considered. The perfect transistor is one which possesses diode junction resistance but no reverse leakage or lead resistance. Although this condition does not exist, the actual or imperfect transistor's characteristics are quite similar to the perfect case. In fact, many design problems can be solved when con-

sidering a perfect transistor, if its thermal sensitivity is neglected. Appendix A is included which covers a brief physics description of the transistor.

Fig. 1 illustrates the physical layout and nomenclature of the perfect junction transistor. When a collector supply voltage, $E_{cc}$, is applied with the polarity as shown in Fig. 2 no significant resulting potential exists across either junction. Each junction can then be considered as an unbiased diode. The free electrons of the emitter region are repelled toward the emitter junction where they see an open circuit halting further progress.

Observation of Fig. 3 shows that non-conduction conditions do not change when the polarity of $E_{cc}$ is reversed.

When a base supply voltage, $E_{bb}$, is applied (Fig. 4), a potential exists across the emitter junction. This junction can be considered as a reversed bias diode which cannot conduct. Now $E_{bb}$ is reversed as shown in Fig. 5 which is of the proper polarity to cause the emitter junction to conduct. The magnitude of current flow is dependent upon the potential across the junction which follows the standard exponential semiconductor diode curve graphed in Fig. 6.

With the base and collector supplies connected as shown in Fig. 7, the conditions for a properly biased transistor exist. That is, the transistor is now capable of amplifying.

By choosing a value of $E_{bb}$ along the $e$ vs. $i$ curve of Fig. 6 a value of $i_b$ is established. The emitter to base junction resistance is also fixed at this point $\frac{E_{bb}}{(i_b)}$. It can be noted that this resistance decreases with increases in $E_{bb}$. The collector circuit is now considered with the emitter junction conducting at the chosen point. The electrons which had previously been repelled to the open circuited emitter junction now see a finite junction resistance and enter into the base region. The first electron entering the base is further repelled deeper into the base region by following electrons. This action is repeated until the initial electrons diffuse to the potential barrier (described in the appendix) existing at the collector junction. The polarity of the potential barrier field accelerates the electrons into the collector region. There the reversed biased field existing throughout the collector region attracts electrons which then drift along the lines of force to the collector terminal. The magnitude of the collector field due to $E_{cc}(v_{ce})$ does not affect collector current $i_c$ as shown in Fig. 8. This is so since the field can only collect electrons that are made available to it, which are those injected from the base. In turn, those electrons arriving from the base have been determined by the emitter junction voltage, $E_{bb}$. Any sustained acceleration given to an electron by an increased $E_{cc}$ is inhibited en route by the increased collision velocity with collector region atoms.

The magnitude of $i_b$ as explained is established by ohms law across the emitter junction. However, the collector current, $i_c$, crosses two junctions and two fields which have a combined effect on its magnitude.

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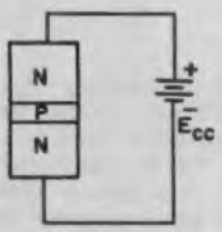



Fig. 2: No significant resulting potential exists across either junction.

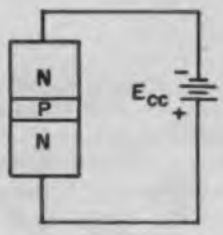



Fig. 3: Non-conduction conditions do not change when $E_{cc}$ polarity is reversed.

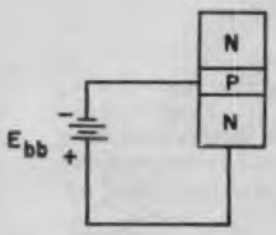



Fig. 4: When $E_{bb}$ is applied a potential exists across emitter junction

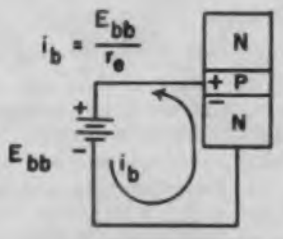



Fig. 5: $E_{bb}$ is proper polarity to cause emitter junction to conduct.

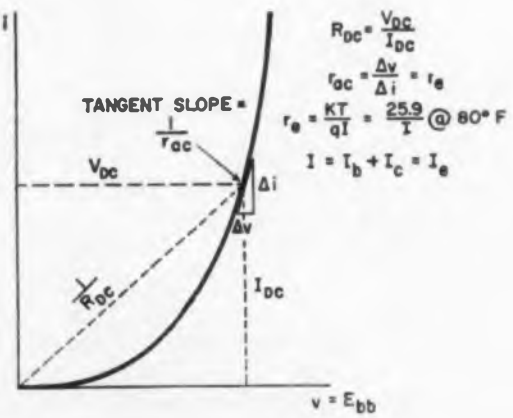



Fig. 6: The standard exponential semiconductor diode curve.

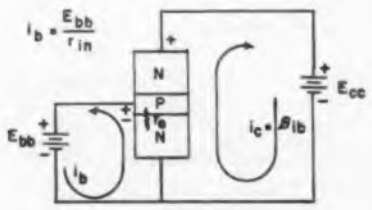



Fig. 7: With connections shown, transistor is capable of amplifying.

# Transistor Analysis

*(Continued)*

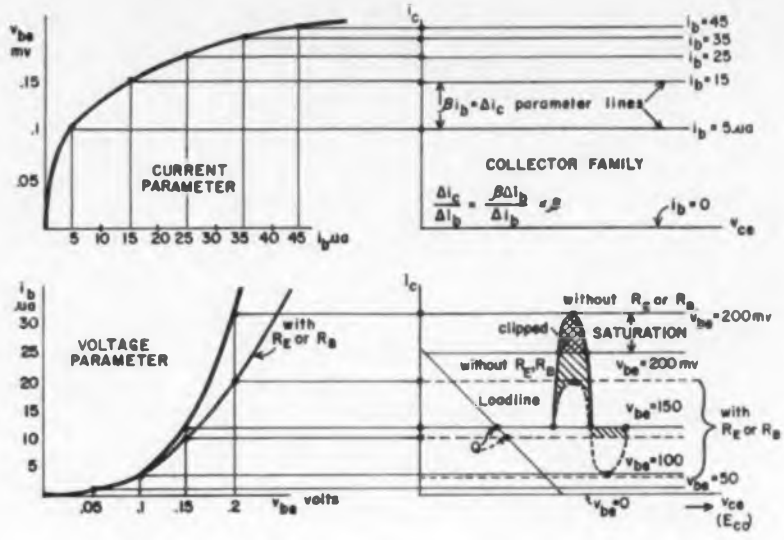



Fig. 8: Figure illustrates the development of the relationship between the base and the collector characteristic curves.

This permits $i_c$ to have a greater magnitude than $i_b$, the ratio of which is the current amplification of the transistor called $\beta$ (beta). This amplification is a fixed, inherent characteristic acquired by the transistor during manufacturing and as explained, does not depend on $E_{cc}$.

A decrease in the base supply voltage, $E_{bb}$, results in a reduction of $i_b$. Accordingly, $i_c$ sees a decreased conductance in its path and also decreases but maintains its magnitude greater than $i_b$ which is the constant, $\beta$ as shown in Fig. 9. Thus, base current $i_b$, effectively controls a much larger collector current $i_c$.

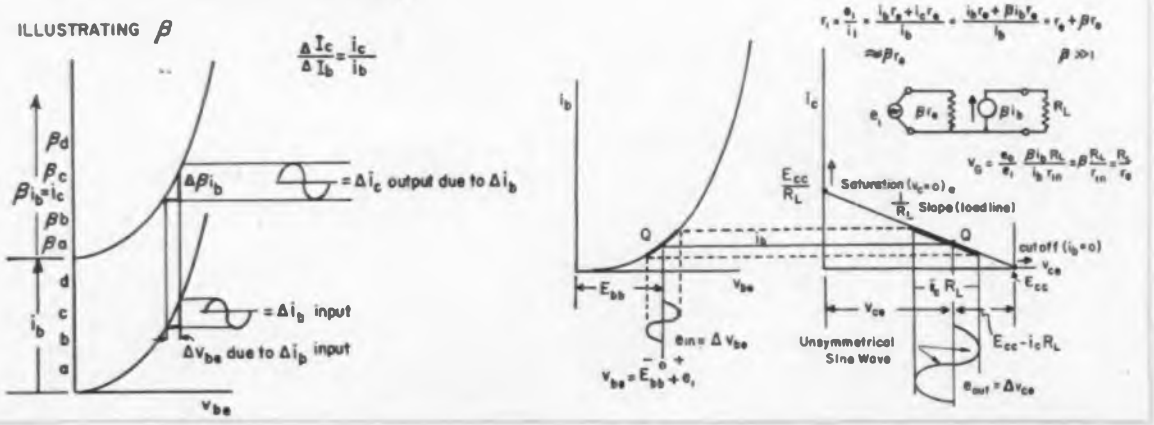
Placing a signal in series with the base supply and a load resistor in series with the collector supply as shown in Fig. 10 produces a simple but operational transistor amplifier. Variations in the signal voltage, as shown, add to or subtract from $E_{bb}$ which changes $i_b$ proportionally. $i_c$ being $\beta$ times greater than $i_b$ follows the changes and produces a relatively large output voltage variation across $R_L$. Hence a voltage, current and power gain is realized by this transistor amplifier.

The emitter junction can be called the "control junction," while $v_{be}$ and/or $i_b$ can be considered the control voltage and/or current.

Although it has been shown that a $E_{bb}$ establishes a

Fig. 10: Placing a signal in series with the base supply and a load resistor in series with the collector supply produces a simple but operational transistor amplifier.

Fig. 9: The base current $i_b$ effectively controls a much larger collector current, $i_c$.



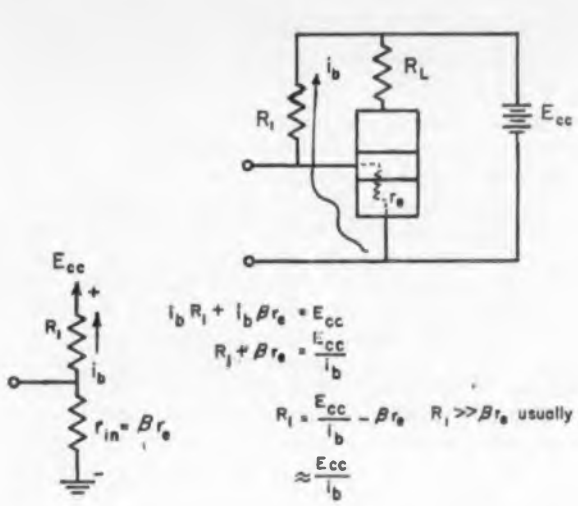
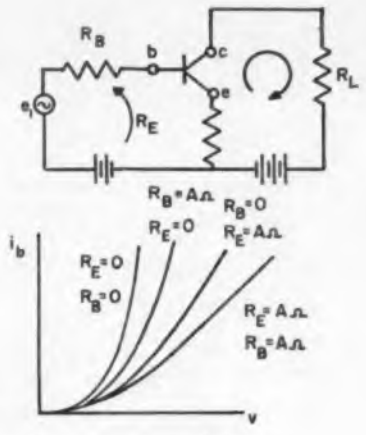



Fig. 11 (left): A common method for finding an $R_1$ which draws the proper $i_b$.




$r_{in} = R_B + \beta (R_e + r_e)$ $\beta \gg 1$

$r_{in} = \beta r_e$ when $R_E = R_B = 0$

$$gm = \frac{i_c}{e_i} = \frac{A_i i_b}{i_b r_{in}} = \frac{A_i}{r_{in}} = \frac{\beta}{r_i}$$

$$V_G = \frac{e_o}{e_i} = \frac{i_c R_L}{i_b r_{in}} = \frac{A_i i_b R_L}{i_b r_i} = Ai \frac{R_L}{r_i} = \beta \frac{R_L}{r_i}$$

$$I_G = \frac{i_c}{i_b} = \frac{A_i i_b}{i_b} = A_i = \beta$$

$$P_G = I_G V_G = A^2 \frac{R_L}{r_i} = \beta^2 \frac{R_L}{r_i}$$

$A_i$ = Current Gain = $I_G$

Fig. 12 (right) Adding $R_B$ reduces distortion. The addition of $R_e$ will further reduce distortion.

specific $i_b$, conversely it is just as true that forcing an $i_b$ through the junction establishes a specific $v_{be}$ ($v_{be} = E_{bb}$ presently) as shown in Fig 8. The figure also shows the converging spaces between the parallel parameter lines due to the exponential emitter characteristic.

Fig. 10 illustrates that a certain voltage $E_{bb}$ is necessary to cause the quiescent $i_b$ which in turn fixes the quiescent $i_c$. After $E_{bb}$ has been calculated it is only necessary that this same potential appear across the emitter junction and a popular alternate method which eliminates a supply source ($E_{bb}$) is shown in Fig. 11. Standard textbooks and manufacturing data sheets adhere to the current concept because of convenient numerical magnitudes and so the figure illustrates the more common method by finding an $R_1$ which draws the proper $i_b$.

An $R_B$ in Fig. 12a reduces distortion by making the emitter junction curve more linear as shown. Distortion can further be reduced more effectively by inserting a resistance, $R_e$, in series with the emitter. $R_e$ like $r_e$ is also in the path of $i_c$ which causes emitter degeneration and results in a voltage drop across $R_e$, $\beta$ times greater than $i_b R_e$. Degeneration due to $i_c R_e$ *of* the input signal is caused by increases of $V_{Re}$ subtracting from the input voltage. This yields less voltage across the junction and, hence, less current.

*Input resistance* is the opposition presented to a source and equals $\frac{e_{in}}{i_{in}}$. By observation it can be seen that inasmuch as the voltage drop across $r_e$ is due mainly to $i_c r_e$ where $i_c$ is $\beta i_b$, the input resistance is increased to $\beta r_e + r_e$ as shown in Fig. 10.

*Output resistance* is the opposition seen by an output source and equals $\frac{e_o}{i_o} = \frac{e_o}{i_c} = \frac{e_o}{0}$ = infinity, since as explained, collector circuit voltage changes produce no current changes.

Presently the readers should be acquiring an insight as to the relative magnitudes of currents and thus, intuitively anticipating component effects on the circuitry. A further feeling of this circuitry should reveal that $r_{in}$ increases with $\beta$, $R_b$, $R_e$ or $r_e$. Reducing either $R_e$, $R_b$ or increasing $R_L$ increases voltage gain. Current gain $\beta$, is constant, $E_{bb}$ is in millivolts, $E_{cc}$ is in volts, $i_b$ is in micro amperes and $i_c$ is in milliamperes for small audio amplifiers and receiver stages.

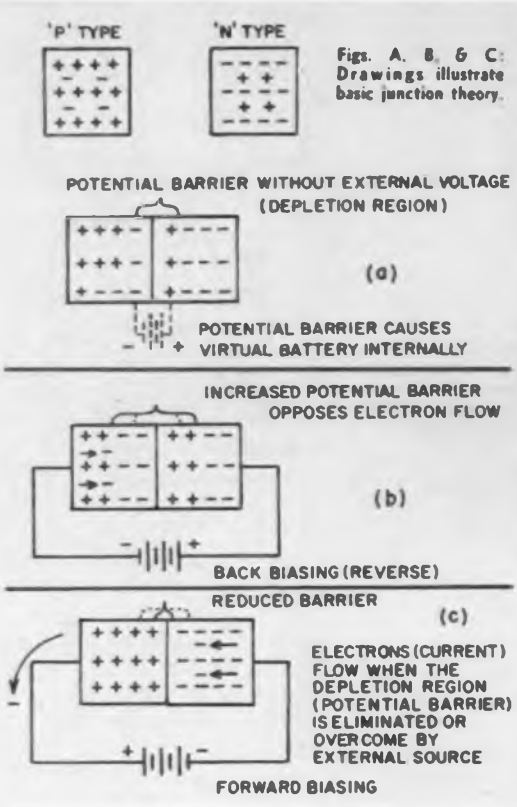
Transistor gain—Formulas for the current, voltage and power gains of the transistor amplifier are derived in Fig. 12b.

### *Appendix A—Junction Theory*

Certain materials that lie in an intermediate range between insulators and conductors in electron mobility are called semiconductors.

When a controlled amount of foreign material is added to a semiconductor, the process is called doping. When a semiconductor is doped with an element that causes it to attain additional free electrons, the semiconductor becomes a N (negative) type. When a semiconductor is doped with a material that causes it to lack free electrons the semiconductor becomes a P (positive) type.

When a N type and a P type material are joined, loosely bound electrons of the N material are pulled




Figs. A, B, & C: Drawings illustrate basic junction theory.

## Transistor Analysis *(Continued)*

away from their atoms and cross the junction to unite with the electron deficient atoms near the junction in the P material.

This process takes place in a small area immediately about the junction as shown in Fig. A. Further transfer of electrons into the P region is halted by the negative charge taken on by the P region atoms that accepted electrons from the N region atoms. The transfer action quickly reaches a state of equilibrium and a total transfer of electrons cannot occur as shown. With the depletion region atoms in the N material becoming positive due to a loss of electrons and the depletion region atoms of the P material becoming negative from accepting electrons there arises a small electric field (potential barrier) due to the charges. Figs. B and C illustrate the effect of connecting external potentials.

The foregoing explanation also applies to ordinary semiconductor diodes as well as transistor junctions.

There are presently used many different semiconductor materials, germanium and silicon being the most common. Germanium is the type considered in this article, and functions similarly to other materials, with two major differences being thermal and voltage sensitivities.

*(Continued Next Month)*

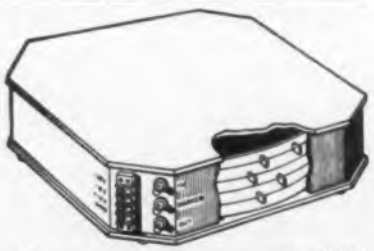
# Function Generator Uses Magnetostrictive Delay Line

A NEW digital function generator is claimed to be more flexible, simpler, and only one-fourth as expensive as present equipment. It is made by Consolidated Avionics Corp., a subsidiary of Consolidated Diesel Electric Corp., 800 Shames Drive, Westbury, N. Y.

Based on a specially-designed torsonial mode magnetostrictive delay line, the function generator is intended for such uses as pulse pattern generation, digital word generation, computer checkout, radar target simulation, dynamic testing, coding and decoding, dynamic data storage, frequency multiplication or division, precise frequency generation, pulse delay generation, coded time multiplication, laboratory circuit development, and many others.

In the digital function generator, the usual control taps are replaced with small permanent magnets held near the delay line. As a pulse, initiated by an input coil, travels down the delay line in the form of a torsional wave, it encounters the fields of the permanent magnets. The inter-action of the torsional wave and the magnetic field generates an output pulse across the ends of the magnetostrictive wire. The time between the initial pulse and the induced pulses depends on how far along the delay line the pulse-forming magnets are placed. Time between induced pulses is directly proportional to the spacing of the magnets. Thus, a pattern can be set up by simply spacing magnets at proper intervals along the delay wire and by picking the pulses off the ends of the wire.

The unit permits delays between the initiating pulse and the induced pulses ranging from 10 to 1000 μsec. Adjacent induced pulses can be as close as 4 μsec.



This cutaway sketch of the new digital function generator shows the mounting of the permanent magnets along the delay wire to provide for the desired pulse pattern.

Permanent magnets are continuously adjustable to any point on the line. As many as 248 magnets can be provided. Standard units are provided with 50 magnets. Regardless of the number of magnets used, there is no attenuation of output signal pulse voltage. Special magnets are available for "end" or "marker" pulses. Such "marker" magnets must be separated from the preceding magnet by at least 8 μsec.

Input drive required to initiate a

*(Continued on Page 214)*

Cinch ELECTRONIC COMPONENTS

**Cinch Hinge Connectors eliminate contact damage caused by the high insertion and extraction forces encountered with ordinary multi-contact (20-100) Connectors... ideal for use in space-limited areas.**

The exclusive Cinch Hinge Connectors are available with 20-100 contacts. Hinge Connectors are ideal for applications where a reliable multi-contact connector is needed for use in a limited area. The **ingenious Hinge and Latch principle** is foolproof and provides added reliability.

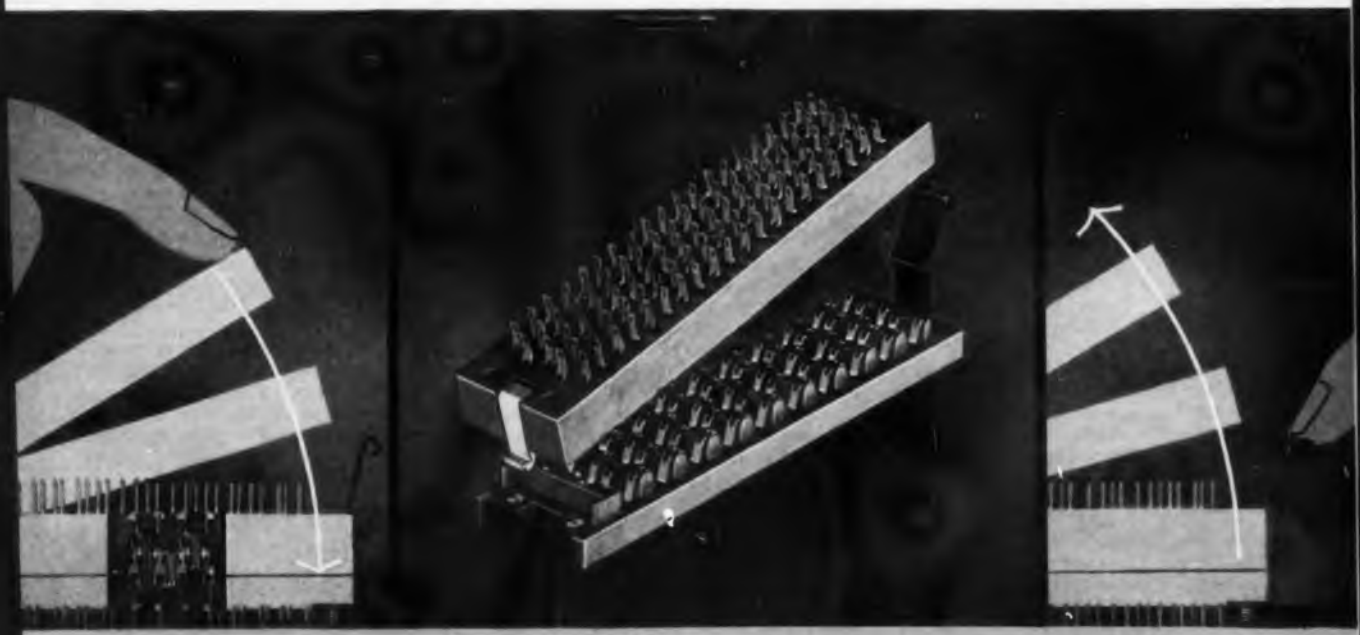
Use of this unique series of connectors eliminates damage to contacts caused by the excessive insertion and extraction forces encountered with ordinary connectors having large numbers of contacts. **Only one finger is necessary** to operate the latching device **to open and close** Cinch Hinge Connectors.

Another feature of the Cinch Hinge Connector is the design of the contacts. **Positive Contact** is always maintained because of the **pressure action** of the wiping contacts. This flexible contact design eliminates high insertion and extraction forces and provides added reliability.

In addition to the Standard Hood for use with 20-100 contact Hinge Connectors, Cinch now has **a new space-saving shallow hood** available for 20-50 contact hinge connectors. Both can be supplied with cable entry holes in top or end, with or without cable clamps and/or liners.

**For further information,** contact the nearest Cinch Sales Office in your area.

# ...AN INGENIOUS CONNECTOR



**CINCH MANUFACTURING COMPANY**
1026 South Homan Avenue, Chicago 24, Illinois
*Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; City of Industry, California; St. Louis, Missouri*

Circle 101 on Inquiry Card

DOT A DIVISION OF UNITED-CARR FASTENER CORPORATION, BOSTON, MASSACHUSETTS

# New Tech Data for Engineers

### Epoxy Casting System

Tech data is available on a new, clear, colorless epoxy casting system designed to cure in 2 hrs. or at temps. as low as 175°F. Thermoset Resin #609 gives castings of perfect clarity yet possesses high physical, electrical and adhesive properties. Thermoset Plastics, Inc., 4015 Millersville Rd., P. O. Box 55244, Indianapolis 5, Ind.

Circle 226 on Inquiry Card

### Copper Clad Laminate

Grade G-10R, a new copper-clad laminate for printed circuitry meets or exceeds NEMA and Mil specs. for room temp. peel strength and has a hot peel strength of 2 to 4 lbs./in. of width. Available in sheets of 36 x 36 in. and 36 x 48 in. with usual copper foil thicknesses. Additional tech information from Synthane Corp., Oaks, Pa.

Circle 227 on Inquiry Card

### Class H Coated Products

This 4-page, 3-color, brochure on coated products for temp. Class H applications lists typical uses, operating temps, and thicknesses, tensile and electrical strengths of silicon rubber coated glass; silicone resin varnish coated glass, and PTFE (Teflon®) coated glass. Dept. W1-515, Irvington Div., Minnesota Mining and Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.

Circle 228 on Inquiry Card

### Silver Alloys

Two silver brazing alloys, Lithobraze 846 and Staflo 691, are the subjects of a new data sheet from Handy & Harman, 850 Third Ave., New York 22, N. Y. These alloys are used primarily for brazing stainless steel honeycomb sections, with the Staflo alloy especially applicable to curved panels. Physical properties, brazing characteristics and brazed joint properties are included.

Circle 229 on Inquiry Card

### Silicone Rubber Base

A new fusible silicone rubber base, specifically designed for fabricating electrical insulating tapes, is described in tech data available from Union Carbide Corp., Silicones Div., 30 E. 42nd St., New York 17, N. Y. Designated Y-3277 base, the material provides the fabricator with flexibility in compounding and offers cost savings.

Circle 230 on Inquiry Card

### Silicone Potting

Two basic types of silicone materials for potting, embedding and encapsulation of electrical and electronic equipment—RTV (room temp. vulcanizing) silicone rubber compounds and a new, transparent clear silicone potting compound, LTV-602 are described in a 2-color, 16-page, guide to the selection and use of these materials. Publication, S-23, gives full information including typical physical and electrical properties, tables, charts and nearly 40 illustrations. Silicone Products Dept., General Electric Co., Waterford, N. Y.

Circle 231 on Inquiry Card

### Anti-Corrosion Metal

Gramix Monel Metal, Gramix Grade 560, has a nominal composition of: nickel, 67%; copper, 30%; and iron, manganese and silicon the balance. Powder-metallurgy parts made of this new material will resist chemical attack by most corrosive media. The United States Graphite Co., Div. of The Wickes Corp., Saginaw, Mich.

Circle 232 on Inquiry Card

### Mica

This 4-page Military Specs. Bulletin, No. 13, incorporates military specs. for Mil-I-3505-C which covers Insulation Sheet and Tape, Electrical Coil and Slot, High Temp., and Mil-I-2107A (ships) covering Insulation Sheet and Tape, Electrical, Reinforced Mica Paper. The Macallen Co., Newmarket, N. H.

Circle 233 on Inquiry Card

### Piezo Ceramics

Tech data on piezoelectric transducer elements, high alumina ceramics, 9-96-99% alumina vessels, metalized ceramics, and high alumina custom shapes, is available from Electro-Ceramics, Inc., 2645 So. 2nd West, Salt Lake City 15, Utah. Information includes: properties; photographs; uses; design suggestions and a list of terms and definitions.

Circle 234 on Inquiry Card

### Laminates

Engineering data on laminated plastics and Tayloron vulcanized fibre is offered by Taylor Fibre Co., Norristown, Pa., in its 1962 condensed catalog. The 8-page, 2-color catalog contains all information necessary for selecting and applying these materials in electrical, electronic and mechanical applications.

Circle 235 on Inquiry Card

### Copper Wire

Engineering data on single strand copper conductors, electroplated with coatings of pure nickel is available from Hudson Wire Co., Ossining Div., Ossining, N. Y. Normally used under high temp. insulations such as Teflon TFE and ceramic coatings, the wires are for use under continuous temps. between 250° and 750°.

Circle 236 on Inquiry Card

### Plastic Standards

Tests and specs. relating to cellular plastics, plastic pipe and such materials as epoxies, urethanes, plastisols and organisols, as well as a test for measuring the tensile strength of plastics under impact conditions are among the 25 new standards in the 12th edition of ASTM Standards on Plastics. This book, compiled by Committee D-20, contains complete information and policies on the field of plastics. ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa. Price $10.00 each; ASTM members, $8.00.

Circle 237 on Inquiry Card

### Lithium Metal

Products list available from the Foote Mineral Co., 18 W. Chelten Ave., Philadelphia 44, Pa., lists lithium chemicals, metal and minerals, electrolytic manganese, zirconium, welding grade products, and steel addition agents for use in the chemical, metallurgical, ceramic, electronic, nuclear and astronautic industries.

Circle 238 on Inquiry Card

### Nylon to Nylon Bonding

A solution to the problem of bonding nylon to nylon surfaces is obtained by the use of RAISEAL 5002, newest of a series of adhesives. Because it is a thermosetting resin, the bond's heat stability is high at temps. up to and above the softening points of most plastics. This material may also be used in the bonding of nylon to most metal and plastic surfaces. Radiation Applications, Inc., 36-40 37th St., L. I. City 1, N. Y.

Circle 239 on Inquiry Card

### Infrared Material

Information concerning production quantities of vertically grown, single crystal indium antimonide p-n junctions is available from Semitronics, Inc., P. O. Box 46, Winchester, Mass. These junctions have been used successfully in infrared detector applications.

Circle 240 on Inquiry Card

# New Tech Data for Engineers

### Clad Metal

To overcome the problem of welding aluminum directly to steel, Metals & Controls Inc., div. Texas Instruments Incorporated, 34 Forest St., Attleboro, Mass., has developed MULtiLAYER™ aluminum clad low-carbon steel. The clad metal, with aluminum on one side and steel on the other, is used as a transition material to weld the steel side to steel and the aluminum side to aluminum. Conventional welding methods are adequate.

Circle 241 on Inquiry Card

### Potting Compounds

Data Sheets 1001, 1011, 1021, 1031, 1041, and 1061, lists the properties of 9 special epoxy resin potting compounds and describe the latest methods of encapsulating and potting critical parts and assemblies. Included are procedures for cleaning of parts, techniques for repairing and patching and stripping methods to use to salvage expensive components. Bacon Industries, Inc., 192 Pleasant St., Watertown 72, Mass.

Circle 242 on Inquiry Card

### Hydroxyacetic Acid

A 24-page booklet complete with corrosion data, characteristic tables and general properties information on hydroxyacetic (glycolic) acid is available from E. I. duPont de Nemours & Co., Inc., Wilmington 98, Del. Some uses of the acid are: adhesives; copper brightening; decontamination cleaning; dyeing; electroplating; and the pickling, cleaning, and chemical milling of metals.

Circle 243 on Inquiry Card

### Microwave Absorbers

Electronautics Corp., Maynard, Mass., has available data sheet #6-9000-1 describing Hi-Pow, a newly developed microwave absorbing material for use in high power terminations, dummy loads and as high temp., high vacuum attenuators. Attenuation at X-band varies from 30db/in. to 200db/in.

Circle 244 on Inquiry Card

### Instrument Catalog

A Short Catalog ES-10, 24 pages, 2 colors, on precision test instruments, lists the complete Bruel & Kjaer line of integrated sound, vibration and data analysis instrumentation. B & K Instruments, Inc., 3044 W. 106th St., Cleveland 11, Ohio.

Circle 245 on Inquiry Card

### Zone Melting

Zone melting apparatus for precise control in solid state purification in zone refining, zone melting and crystal pulling is described in a Technical Review Vol. 2, No. 4 available from Research Specialties Co., 200 So. Garrard Blvd., Richmond, Calif.

Circle 246 on Inquiry Card

### Gold Alloy Baths

A new instructional booklet on antimony, indium, and gallium gold alloy baths is available from Technic, Inc., P. O. Box 965, Providence, R. I. Information includes equipment, preparation procedures, formulae, operation data, and replenishment needs of gold-antimony, antimony gold (barrel plating), gold-indium, and gold-gallium alloy baths. Groups III and V Gold Alloy Baths.

Circle 247 on Inquiry Card

### Laminates

Glass cloth impregnated with high-temp. resistant phenolic resin identified as Grade 5H966, made with style 181 glass fabric, have an A-1100 finish and impregnated with Micarta resin Grade 7H186, is described in tech. information available from Westinghouse Electric Corp., Micarta Div., Hampton, S. C. The material is especially useful for the production of laminates or molded parts for high temp. service.

Circle 248 on Inquiry Card

### Rectifier Catalog

This 44-page, 2-color catalog describes standard silicon power rectifiers and rectifier stacks. The catalog is a composite of 12 data bulletins describing 8 basic silicon power rectifiers and their corresponding standard rectifier stack assemblies. Illustrations include complete tabulations of electrical data, characteristic curves and dimensional diagrams. Silicon rectifiers range from 6 to 240a. with max. PRV ranging from 50 to 600v. Ratings for the stacks are from 12 to 370a., 1$\phi$, and from 18 to 520a., 3-phase. Available from Rectifier-Capacitor Div., Fansteel Metallurgical Corp., N. Chicago, Ill.

Circle 249 on Inquiry Card

### Microwave Oscillators

Catalog 61-A from Trak Microwave Corp., 5006 N. Coolidge Ave., Tampa, Fla., gives illustrations, specs. and performance curves for miniature microwave oscillators.

Circle 250 on Inquiry Card

### Magnetic Clutches

Catalog #100, 140 pages, available from SIAMCO, Div. of Tech-Ohm Electronics, Inc., 36-11 33rd St., Long Island City 6, N. Y., features precision gears, magnetic clutches and brakes, differentials, couplings, gear heads, limit stops, bearings, and other electronic hardware.

Circle 251 on Inquiry Card

### Delay Lines

A designer's booklet available from Corning Electronic Components, Corning Glass Works, Bradford, Pa., describes recently-developed digital delay lines that combine high speed, low access time, high reliability and low cost. Operating data, as well as characteristics of the transducer and delay medium, are detailed for each series.

Circle 252 on Inquiry Card

### Zener Diode

International Rectifier Corp., 233 Kansas St., El Segundo, Calif., is offering the following: Rectifier News, Summer/1961, 8 pages, containing a tech. article "How to Produce Repetitive High Current Pulses with a Silicon Controlled Rectifier Oscillator"; Subminiature Glass Zener Diode Bulletin SR-265, 6 pages, catalog on glass zener diodes provided ratings, characteristics, uses and power dissipation data on over 270 JEDEC and IR High Spec. diode types; Selenium Rectifier Stack Bulletin SR-170, 6 pages, catalog on selenium rectifier stacks covering a variety of possible stack variations, including standard and high voltage types and new double and triple density cell types.

Circle 253 on Inquiry Card

### Data Acquisition System

MicroSADIC, an integrated, high-speed, general purpose solid state system capable of sampling several hundred channels of analog data at up to 15,000 samples/sec. is described in a 16-page, 2-color, brochure available from Consolidated Systems Corp., 1500 So. Shamrock Ave., Monrovia, Calif. Bulletin 3047.

Circle 254 on Inquiry Card

### Encapsulation

Encapsulation of resistors and capacitors in a heat shrinkable Thermofit sleeve is described in a new bulletin by Rayclad Tubes, Inc., Redwood City, Calif. The technique is suited for low cost automated production.

Circle 255 on Inquiry Card

# New Tech Data for Engineers

### Connectors

Electrical and physical information on Molded Pin Power Connectors, Series RP and MP, is available from Lionel Electronic Laboratories, div. of The Lionel Corp., 1226 Flushing Ave., Brooklyn 37, N. Y. The data sheets include a series of dimensional drawings and a review of the materials used in the series which meet applicable paragraphs of Mil-C-8384 and Mil-C-5015.

Circle 256 on Inquiry Card

### Semiconductors

Tech Tips available from Westinghouse Semiconductor Dept., Youngwood, Pa., gives information on silicon power semiconductors and the recommended mounting practices.

Circle 257 on Inquiry Card

### Voltage Regulators

Tech data information is available micro miniature voltage regulators. Bendix® types TD-9A and TD-19 are cold cathods gas filled diodes designed for use as voltage stabilizing elements in low current applications. Included are photographs, schematics, and characteristic charts. Also available is information on microwave ferrite components for advanced concepts in microwave circuitry. Specs. and photographs are included. Electron Tube Products, Bendix Corp., Red Bank Div., Eatontown, N. J.

Circle 258 on Inquiry Card

### Helixing Lathes

A 4-page catalog describing an extensive line of specialized automatic machinery for production and testing of film type resistors is available from Industrial Instruments, Inc., 89 Commerce Rd., Cedar Grove, N. J. Information on resistor sizes accommodated, the production rate and accuracy, feeding and handling methods for both leaded and unleaded resistors is provided.

Circle 259 on Inquiry Card

### Multi-Function Tubes

Information on 35 types of "COMPACTRON" devices is now available as engineering samples for designers of radio, television and other equipment in a new booklet. Reliability, life expectancy, power, sensitivity, and typical circuitry are discussed in the publication (ETD-2734). General Electric, Receiving Tube Dept., Owensboro, Ky.

Circle 260 on Inquiry Card

### Vacuum System

Model SEL 823 vacuum system is designed for routine $10^{-9}$, $10^{-10}$ mm Hg vacuum operation. Suited for advanced thin-film deposition techniques, as well as use in the fields of Optics, Metallurgy and Space research. Complete specs. together with informative folder available from Scientific Engineering Laboratories, Inc., P. O. Box 607, Woodland, Calif.

Circle 261 on Inquiry Card

### Power Transistors

Semi-Onics, Inc., 4 Broadway, Lowell, Mass., has tech data available on their new line of pnp germanium power transistors in TO-36 packages. Features include: Low package height; 150w. power dissipation; 0.5°C/w. thermal resistance and 100°C junction temp. Electrical characteristics offer a beta range of 20-70 @ 5a. $I_c$ and a $BV_{CBO}$ range of 40-100v. Information is on the 2N173, 174, 277, 278, 442, 443, 1099, 1100, 1358 and 1412.

Circle 262 on Inquiry Card

### Solid State Inverters

Electrosolids Corp., 12740 San Fernando Rd., North, Sylmar, Calif., is offering tech data on ZERO to ZERO power factor solid state inverters. The new design is available either as an inverter or coupled with a transformer rectifier for freq. and/or voltage conversion.

Circle 263 on Inquiry Card

### Stereophony

"Operational Research on Microphone and Studio Techniques in Stereophony" is available for 5 shillings from BBC Publications, 35 Marylebone High St., London, W.1, England. Some of the material covered includes microphones; the M-S system; effect of attenuating M or S signals; compatibility; microphone position; use of difference signal for special effects; studios and listening rooms; and control equipment.

### Tunnel Diodes

Tech data is available on a new series of high current silicon tunnel diodes featuring peak current values to 4a. Types HT-25, 26 and 27, have output voltages up to 0.8v. and typical switching times of 5nsec. Semiconductor Div., Hoffman Electronics Corp., 1001 No. Arden Dr., El Monte, Calif.

Circle 265 on Inquiry Card

### Chopper Catalog

This 12-page, 2-color general instrument chopper catalog gives complete data on all military and industrial choppers including miniature SPDT and DPDT models, applicable Mil specs., residual noise and drift data, mechanical and electrical specs., incoming inspection and engineering measurement techniques. James Electronics, Inc., 4050 N. Rockwell St., Chicago 18, Ill.

Circle 266 on Inquiry Card

### Coaxial Connectors

A 10-page catalog completely describing a new line of subminiature coaxial connectors is available from The Deutsch Co., Electronic Components Div., Municipal Airport, Banning, Calif. Information includes specs., performance characteristics and availability data on these all crimp terminated r-f connectors.

Circle 267 on Inquiry Card

### Ceramic-to-Metals Seals

A 32-page catalog covering over 40 standard types of high-alumina terminals, all of which remain high-vacuum-tight during continuous operation 350°C in air is available from Ceramseal, Inc., New Lebanon Center, N. Y.

Circle 268 on Inquiry Card

### TWT Stack Assemblies

Tech data is available on PPM TWT stack assemblies designed to customer specs. In addition to Alnico V, VI, and INDOX I, ISP now offers Alnico VIII and INDOX VI-A permanent magnets for TWT applications. Special calibration equipment designed for use with TWT assembly section, makes possible closer tolerances on a production basis. Complete spec. data on Alnico VIII (Bulletin 363), INDOX VI-A (Bulletin 373) and TWT Calibrating Equipment (Bulletin 374) is available from Indiana Steel Products Div., Indiana General Corp., Valparaiso, Ind.

Circle 269 on Inquiry Card

### Electrolytic Capacitors

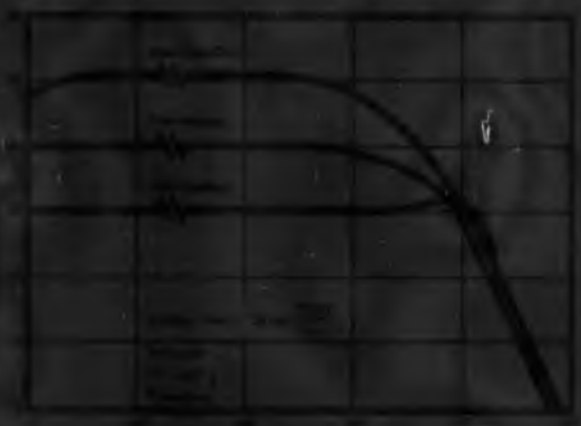
Miniature electrolytic capacitors for low voltage dc transistor use are described in a 6-page, 2-color fold-out available from International Electronic Industries, Inc., Box 9036, Nashville, Tenn. Features of these miniature units are ultra-small case sizes; high capacities with max. economy; and wide range of voltages and capacities.

Circle 270 on Inquiry Card

**DALMESA**

APPLICATION REPORT NUMBER 3

PERFORMANCE DATA



WIDE-BAND VHF AMPLIFIER

# Apply Low-Noise, Low-Cost DALMESA Transistors to Your Wide-Band Amplifier Designs

■ **Solve your industrial communications design problems today** with TI's new **DALMESA** 2N2188 series. This new germanium alloy diffused mesa transistor family is specifically designed to meet your requirements for high-performance, low-noise, economically-priced transistors for application over the entire communications band from dc to 150 mc. ■ The **extremely low, low-frequency noise corner** and **high alpha cutoff frequency** offered by new **DALMESA** transistors result in **low-noise performance over a very wide bandwidth** — the 2N2188 series gives you a typical mid-frequency noise figure of 1.5 db. ■ These new devices also give you **guaranteed gain/bandwidth products of 60 and 102 mc** to assure excellent performance in your IF, RF and video amplifiers. **Increased high-frequency stability** results from the guaranteed maximum **output capacitance of 2.5 pf at 9 volts.** ■ Apply new **DALMESA** transistors to your communications designs today and take advantage of the increased performance capabilities of this new Texas Instruments series. These new 125-mw transistors are **immediately available** through your nearest TI Sales Office or Authorized TI Distributor.

| PARAMETER | TEST CONDITIONS | 2N2188 | 2N2189 | 2N2190 | 2N2191 |
|---|---|---|---|---|---|
| $BV_{CBO}$† AND $BV_{CES}$ | $I_C = -50\ \mu a$ | 40 v min | 40 v min | 60 v min | 60 v min |
| $BV_{EBO}$ | $I_C = 0, I_E = -100\ \mu a$ | 2 v min | 2 v min | 2 v min | 2 v min |
| $h_{FE}$ | $V_{CE} = -6$ v, $I_C = -2$ ma | 40 min | 60 min | 40 min | 60 min |
| $h_{fe}$ (at 1 kc) | $V_{CE} = -6$ v, $I_E = -2$ ma | 40 min | 60 min | 40 min | 60 min |
| $f_T$ | $V_{CE} = -9$ v, $I_E = -1.5$ ma | 60 mc min | 102 mc min | 60 mc min | 102 mc min |
| $I_{CBO}$ | $V_{CB} = -12$ v, $I_E = 0$ | 3 $\mu a$ max | 3 $\mu a$ max | 3 $\mu a$ max | 3 $\mu a$ max |
| $C_{OB}$ (at 1 mc) | $V_{CB} = -9$ v, $I_E = 1.5$ ma | 2.5 pf max | 2.5 pf max | 2.5 pf max | 2.5 pf max |
| Noise Figures § (at 1 mc) | $V_{CE} = -5$ v, $I_E = 0.5$ ma | 1.5 db typ | 1.5 db typ | 1.5 db typ | 1.5 db typ |
| Maximum Power Dissipation | 25°C Ambient | 125 mw | 125 mw | 125 mw | 125 mw |

† $I_E = 0$ §$R_G = 1K\Omega$

Circle 102 on Inquiry Card

TRANSISTOR PRODUCTS DIVISION

**TEXAS INSTRUMENTS**
**INCORPORATED**
13500 N. CENTRAL EXPRESSWAY
P. O. BOX 5012 • DALLAS 22, TEXAS

18767

# New Tech Data for Engineers

### DC Ratiometer

Tech data is available on a new low-cost DC ratiometer with full five-digit resolution. The R65A offers plug-in stepping switches, precision wire-wound resistors and snap-out readout for fast bulb replacement. It will measure dc voltage ratio from 0.00001:1 to 0.99999:1 with an accuracy of 0.01% of reading plus 1 digit. Balancing time averages 2 sec. Input impedance is 1000 megs. Non-Linear Systems, Inc., Del Mar, Calif.

Circle 271 on Inquiry Card

### Germanium Diode

Nanosecond Germanium Diode Type CGD-1092 and 1093 are described in 4 spec. sheets available from Clevite Transistor Products, 241 Crescent St., Boston 54, Mass. Technical ratings for the 1092 include a reverse recovery time of 8.0nsec. max.; max. capacitance of 1.5pf. @ 3.0v.; average power dissipation of 80mw.; and ambient temp. range of −65 to +90°C. Specs. on the 1093 include a reverse recovery time of 3.0nsec. max.; max. capacitance of 2.0pf. @ 3.0v.; and $i_{SCROE}$ for 1 sec. of 150ma.

Circle 272 on Inquiry Card

### Enclosure Tubes

Metallized glass enclosure tubes that can withstand down-shock from 275°C to ice water are described in reference File CE-6.00, available from Corning Electronic Components, Corning Glass Works, Bradford, Pa.

Circle 273 on Inquiry Card

### Waveguide Adapters

This 2-color, 19-page catalog, JS-61A, contains mechanical data on various types of sidewall and topwall waveguide adapters covering EIA waveguide sizes from WR28 to WR187. Two pages of drawings are provided to facilitate reference for special adapter requirements. Dimensions are tabulated with and without flanges. Microwave Development Laboratories, Inc., 15 Strathmore Rd., Natick Industrial Center, Natick, Mass.

Circle 274 on Inquiry Card

### Card Reader

Tech data is available on the Speedreader 2000 a system using photosensing. It reads cards at speeds from 400 to 3000 cards/min. Speedreader 2000 reads any number of columns in cards of either the Remington Rand or IBM type. Hopper capacities are 4000 cards. Uptime Corp., 175 Commerce St., Broomfield, Colo.

Circle 275 on Inquiry Card

### Discharge Capacitors

"Energy Discharge Capacitors" available from Sangamo Electric Co., Springfield, Ill., describes design criteria in respect to a new and important field of capacitor use. Giving both mechanical and electrical design information, the bulletin on capacitors is for use in impulse generators, hypersonic wind tunnels, laser equipments, magnetic forming, shock wave experiments, and ion propulsion.

Circle 276 on Inquiry Card

### Boron Hydrides

Chemical Safety Data Sheet SD-84 entitled, "Properties and Essential Information for Safe Handling and Use of Boron Hydrides" is now available from the Manufacturing Chemists' Association, Inc., 1825 Connecticut Ave., N.W., Washington 9, D. C. The sheet details the properties, hazards, employee safety, fire fighting practices, handling and storage, and first aid treatment. Price 30¢.

Circle 277 on Inquiry Card

### Antenna Testing

Complete systems for radome and antenna testing and dielectric measurements, including production testing with laboratory accuracy, are described in an illustrated, 4-page, 3-color brochure available from Dunn Engineering Corp., 225 O'Brien Hwy., Cambridge 41, Mass. Bulletin No. R1000.

Circle 278 on Inquiry Card

### Contamination Control

A 4-page, 2-color brochure is available from Central Vacuum Corp., 3008 E. Olympic Blvd., Los Angeles 23, Calif., on micro vacuuming. This method developed by Central Vacuum is for: vacuuming personnel prior to entry into "White Rooms"; keep them dust-free; and insure immaculate assemblies. Information includes: inlets; hoses; suction control valves; shoe cleaners; dual systems for large installations; and general plant maintenance.

Circle 279 on Inquiry Card

### Glass-to-Metal Seals

A new "Chontrol" heat treating method, permitting the complete control of the metallurgical characteristics of materials, has been developed for use in fabricating glass-to-metal seal devices. Information is available from Precision Products Co., Inc., 26 Bedford St., Waltham 54, Mass.

Circle 280 on Inquiry Card

### SSB Modulators

Tech information on single sideband modulators to cover the C- to Ku-band range is available from Radiation Div., Varian Associates, 611 Hansen Way, Palo Alto, Calif. Typical figures include conversion loss 10db; max. carrier input power 600mw; carrier and unwanted sideband suppression 20db below desired sideband; and harmonic sidebands 15db below desired sideband.

Circle 281 on Inquiry Card

### Miniature Oscillators

Four miniature transistorized crystal-controlled oscillators designed for missile and satellite applications are described in a catalogue sheet available from the Electronics Div., Bulova Watch Co., Inc., 40-01 61st St., Woodside 77, N. Y.

Circle 282 on Inquiry Card

### Semiconductor Networks

Series 51 SOLID CIRCUIT® semiconductor networks have the following features: advanced package design; low power drain; military performance; and are fabricated from a standard silicon wafer. This series of 6 digital networks requiring only a 1 $\phi$ clock source fulfill the logic functions of a complete equipment assembly, such as the arithmetic or control section of a computer. Typical power drain of 2 to 4mw ($V^{cc} = 3v.$) per logic network. Operating temp. range, −55 to +125°C; supply voltage, +3 to +6v., in hermetically sealed packages. Texas Instruments Incorporated, Components Div., 13500 N. Central Expressway, P. O. Box 5012, Dallas 22, Tex.

Circle 283 on Inquiry Card

### Transistor Bases

Tech data is available on both compression and strain-free types of transistor bases. Photographs, dimensional drawings and complete specs are included. Electrical Industries, div. of Philips Electronics & Pharmaceutical Industries Corp., Murray Hill, N. J.

Circle 284 on Inquiry Card

### Voltmeters

An 8-page short form catalog containing illustrations and technical data of precision, laboratory-type voltmeters, decade amplifiers, calibrators, capacitance meters, ac/dc converters, and dc/ac inverters, available from Ballantine Laboratories, Boonton, N. J.

Circle 285 on Inquiry Card

# Presenting Bourns Trimpot® Model 3300 – The Only Potentiometer with All These Features:

NUMBER 20—NEW PRODUCT SERIES

(1) Smaller-than-transistor size—just 5/16" dia. x 3/16".
(2) Resistance from 50Ω to 20K.
(3) Full compliance to MIL Specs for cycling humidity, sand, dust, salt spray, fungus (meets MIL-STD-202, MIL-E-5272).
(4) Positive end stops.
(5) Precious-metal contacts.
(6) Sealed lightweight plastic case (no shorts to the board).
(7) Industry-standard pin arrangement.
(8) Exclusive Silverweld® multi-wire termination (virtually indestructible under thermal or mechanical stress).

The single-turn, 0.5 watt Model 3300 is as tough as it is tiny. It stands up to 175°C heat, 30G vibration and 100G shock. Its quality is checked by 100% inspection and double-checked by the rigid Bourns Reliability Assurance Program. In every unit, the performance you specify is the performance you get.

Production quantities available immediately with either printed circuit pins or solder lugs and bushing mount. Write for complete data.


Manufacturer: Trimpot® potentiometers; transducers for position, pressure, acceleration. Plants: Riverside, California; Ames, Iowa; and Toronto, Canada

# New Products . . . for the Electronic Industries

## CARBON POTENTIOMETER

*Offers high package density and high stability.*

Trimpot® Model 3001 provides high temp. and good moisture stability. It operates at temps. to 150°C and under cycling humidity conditions with resistance shift only ⅛ that of ordinary carbon units. Specs: Resistance range —20K to 1 Meg; Power rating—0.2 w. at 70°C; Electrical rotation—15 turns nominal (wiper assembly idles at both ends of travel to prevent damage from forced adjustment); Operating Temps. —65 to +150°C; Size ¾ x 5/32 x 5/16 in. Bourns, Inc., 6135 Magnolia Ave., Riverside, Calif.

Circle 166 on Inquiry Card

## TRANSISTOR CIRCUIT-MOUNT

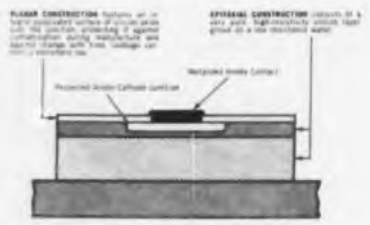
*For testing high freq. transistors in UHF or microwave region.*

The Universal Transistor Circuit-mount in TRI-PLATE® Strip Transmission Line permits accurate measurement of $f_{t,m}$, $t_r$, and other critical circuit parameters. For extremely fast pulse work, the single module can be used to breadboard almost all grounded emitter or grounded base circuits. It offers flexibility with 8 special mounting cavities for insertion of standard lumped components such as resistors, capacitors, etc. Sanders Assoc., Inc., Microwave Products Dept., 95 Canal St., Nashua, N. H.

Circle 168 on Inquiry Card

## PLANAR EPITAXIAL DIODE

*It combines ultra-fast switching and high conductance.*

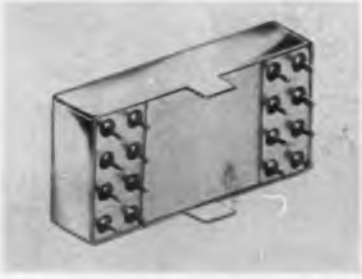


The FD 600, features a reverse recovery time which is typically 2nsec. and a guaranteed 200ma. min. $I_F$ at 1v. It is for such applications as avalanche circuitry, core driving and logarithmic amplifiers for pulse amplifiers. Other guaranteed electrical characteristics: Breakdown voltage, 75v. min. at 5μa.; Capacitance, 2pf. max. at 0v.; Reverse current, 50na. max. at 50v.; and Power dissipation of 500mw. at 25°C. Fairchild Semiconductor Corp., 545 Whisman Rd., Mountain View, Calif.

Circle 170 on Inquiry Card

## CROSSPOINT RELAY

*It uses miniature reed switches for coordinate network switching.*



Features include: Operating time of 2.0msec. max. long maintenance-free contact life; high contact reliability; low operating power; small size; and ease of mounting on printed circuit cards using conventional 0.1 in. grid spacing. Standard construction includes 5 miniature reed switches surrounded by 3 coils with the entire assembly encased in a magnetically shielding enclosure 1⅝ x 13/16 x ⅜ in. Contacts rated 4w., 250v. max., 125ma. max. Struthers-Dunn, Inc., Pitman, N. J.

Circle 167 on Inquiry Card

## MINIATURE RHEOSTAT

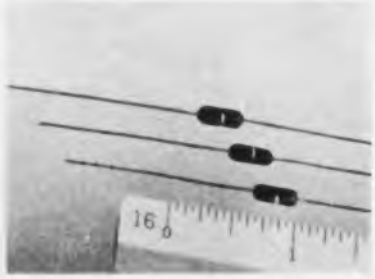
*The Model E (12½w.) comes with "tapered" windings where specified.*

In certain applications, a number of advantages are obtained from tapered windings. They are: more linear control of certain loads; higher max. resistance for a given current rating; specific resistance vs rotation curves can be produced. Only ⅞ in. in dia. and extending 11/16 in. behind the mounting panel, the Model E rheostat has a ceramic hub, independent contact arm pressure, vitreous enamel coating, and metal graphite contact. Ohmite Mfg. Co., 3645 Howard St., Skokie, Ill.

Circle 169 on Inquiry Card

## CERAMIC CAPACITORS

*They are designed for bypass-coupling, filtering and blocking circuits.*



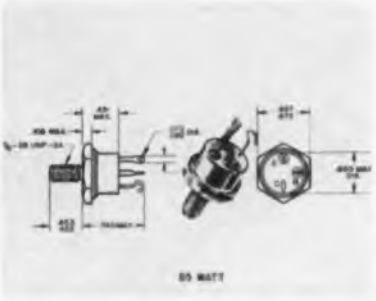
These 2 units, 50wvdc and 200wvdc are made in a conformal body coating with tinned copper or weldable alloy axial leads. These Cerol capacitors will meet or exceed all the requirements of Mil-C-11015B when tested using applicable ratings. Ratings for both capacitors are @ 85°C, and derated by 50% @ 125°C. Specs. are: T.C. : +10% - 30%, —55 to +125°C, @ 0v.; +10% - 40%, —55 to +125°C @ 8 to 10MC.; Power factor, 2% max. Hi-Q Div., Aerovox Corp., Olean, N. Y.

Circle 171 on Inquiry Card

# New Products . . . for the Electronic Industries

## POWER TRANSISTORS

*Silicon power units for switching and amp. use dissipate 85 w.*



The 2N1212 and 2N1208 are diffused junction npn silicon transistors designed for high power switching and amp. applications, operating in the temp. range of −65°C to +200°C. These transistors meet the environmental requirements of Mil-S-19500B. Other specs.: VCE—60 v.; VCB—60 v.; VEB—10 v.; IC—5 a.; Power dissipation, at case temp. of 25°C—85 w.; at case temp. of 100°C—45 w. Silicon Transistor Corp., Carle Place, N. Y.

Circle 172 on Inquiry Card

## FREQUENCY STANDARD

*Available with an output of 1MC or any freq. from 500KC to 20MC.*

These are for use in test and control equipment where high freq. stability is required. Crystal oscillator and amplifier circuitry combined in a precision controlled oven for high stability at lower cost. Specs: Freq. tolerance, ±0.00002% (2 parts in $10^7$) over the temp. range of ±20 to +40°C or ±0.00005% (5 parts in $10^7$), −30 to +60°C; Input, 24 to 28vdc. ±10% (for ocs.-amp). Greenray Industries, Inc., 5281 E. Simpson Rd., Mechanicsburg, Pa.

Circle 174 on Inquiry Card

## THUMBWHEEL SWITCHES

*Substantial savings in systems space and cost are offered.*

This line of 3 printed circuit units occupy ½ in. panel space and have outputs of all-shorting-but-one (Type TTS-2722), progressively shorting (Type TTS-27150), and progressively unshorting (Type TTS-27158). They will eliminates relays and stepping switches. All 3 types are also available in multi-wafer combinations to produce additional digital and binary functions. Chicago Dynamic Industries, Inc., Precision Products Div., 1725 Diversey Blvd., Chicago 14, Ill.

Circle 176 on Inquiry Card

## LAMP ASSEMBLY

*Can be mounted on horizontal and vertical centers as close as ⅜ in.*

This series of TECLITES—RLA replaceable lamp assembly offers a combination of terminal strips and lamp sockets using conventional standoffs—or a new, optional mounting that eliminates mounting screws on the panel. Unlimited lengths and widths of displays on ⅜, ½, ¾, and 1 in. centers possible using the RLA series indicator lites. Twelve lens colors are available. TEC-LITE Div., Transistor Electronics Corp., 3357 Republic Ave., Minneapolis 26, Minn.

Circle 173 on Inquiry Card

## SILICON RECTIFIER

*Double diffused 20 a. power units are mounted in 50 a. cases.*

Both types are designed for use in industrial power supplies, battery chargers, induction and dielectric heating equipment and broadcast transmitters. They can also be used in series parallel arrangements for heavy duty applications. The recurrent PIV rating, 400v., is supplemented by a transient PIV ratings: 600v. for type BYZ14 and 800v. for the BYY15. Amperex Electronic Corp., Power Tube Div., 230 Duffy Ave., Hicksville, L. I., N. Y.

Circle 175 on Inquiry Card

## COMPONENT HOLDERS

*They provide contact points at any coordinate on an X-Y axis.*

They are for use with the Sealectoboard program board. Any 2-lead component, diodes, ⅛ w. resistors, etc., less than ½ in. long x ⅛ in. dia. with leads of #22 AWG or smaller dia., 1 in. min. length, may be used in the Sealectoboard component holder. The component holders are available in either standard EIA color coding, or transparent plastic allowing identification by color code or markings on component proper. Sealectro Corp., 610 Fayette Ave., Mamaronek, N. Y.

Circle 177 on Inquiry Card

# New Products . . . for the Electronic Industries

## CONNECTORS

*These printed circuit connectors have 7, 11, 15, 19 or 23 contacts.*

NAS-714 Series and NAS-715 Series meet all the requirements of NAS-713 specs. They also feature additional improvements such as closed entry, removable, socket contact for solder or crimp termination in NAS-714 type receptacle. Split type sockets are optional. NAS-715 circuit board plugs also feature removable contacts to provide max. economy. Crimp type sockets meet Mil-C-26632 for termination. Methode Electronics, Inc., 7447 W. Wilson Ave., Chicago 31, Ill.

Circle 178 on Inquiry Card

## FUNCTION GENERATOR

*Type 250 gives square, triangular, sine, cosine, and ramp waveforms.*

It also offers independent or simultaneous output of all 5 over a freq. range from 0.001 to 10,000CPS. The unit features external triggering to manual triggering and continuous operation; delivers 30v. at 25ma. main output or 30v. at 5ma. auxiliary outputs. Reference level variable for above and below-ground waveforms. Amplitude variation over the instrument's 10-million-to-one timing range said to be under 5%. Exact Electronics, Inc., P. O. Box 234, Hillsboro, Ore.

Circle 180 on Inquiry Card

## TRANSISTOR BASES

*They are available in matched and compression type seals.*

The line of hermetically sealed transistor bases include types for JEDEC Series T05, T09, T018, T033 and T046 packages, miniatures for hearing aids and other applications, and bases for practically all military and commercial requirements. They come in a broad selection of terminal configurations. Finishes include Brite gold, electro-tin and high purity gold for direct fusion of semiconductor elements to header base. Electrical Industries, 691 Central Ave., Murray Hill, N. J.

Circle 182 on Inquiry Card

## SELENIUM RECTIFIERS

*Epoxy-sealed bridge rated at 26 v. RMS input, 10 a dc output.*

Production units are available with ratings up to 130 v. New high-efficiency natural P-N junction generates less heat than conventional selenium rectifiers, and conduction cooling keeps operating temps. still lower for substantial space savings/given rating. Fourth terminal of the bridge, in unit shown, is the case itself, but it is also available with isolated case and separate, fourth lug. Radio Receptor Co., Inc., 240 Wythe Ave., Brooklyn 11, N. Y.

Circle 179 on Inquiry Card

## VARIABLE ATTENUATOR

*Type RT-1 covers from 0-3GC with a range of 0-60db ± 2db.*

It presents max. voltage standing-wave ratios of 1.2 and 1.4 at input and output, respectively and is available in models with 50-, 60-, and 75Ω impedances. The power-handling capacity is 0.5 w. Measuring only 3¾ in. dia. x 4 in. deep, the device is for use as a laboratory general-purpose attenuator or as a component for building into equipment. Industrial Products Div. International Telephone and Telegraph Corp., San Fernando, Calif.

Circle 181 on Inquiry Card

## SCR

*C5 series may be used as a high voltage pnp transistor.*

This all diffused, low current Silicon Controlled Rectifier comes in the standard JEDEC T05 housing. It may be used as a sensitive signal amplifier. The 8 models differ by $V_{BO}$ which ranges from 25v. for the C5U to 400v. for the C5D. C5 series will accommodate transient PRV up to 500v. $I_F$ rating is 1a dc at 82°C case temp. The max. $i_G$ to fire is 200μa. 25°C. The $i_{GUARON}$—is 18 a. General Electric Co., Rectifier Components Dept., W. Genessee St., Auburn, N. Y.

Circle 183 on Inquiry Card

# New Products . . . for the Electronic Industries

## GERMANIUM DIODE

*This series of nsec. diodes has high resistance to shock and vibration.*

Types CGD-1092 and CGD-1093 operate over an amb. temp. range of −65 to +90°C. At 25°C, Type CGD-1092, with a mercury relay square wave generator and a scope with rise time less than 1.0nsec., switching from 10ma. with 100Ω loop impedance, attains a reverse recovery speed to 1.0ma. at 8.0nsec. Max. Type CGD-1093 attains a reverse recovery speed to 1.0ma. of 3.0nsec. Max. Average power dissipation of both types is 80mw. Clevite Transistor, Dept. N., Waltham, Mass.

Circle 184 on Inquiry Card

## GATE AMPLIFIER

*This unit is for audio use to suppress background noise.*

The amplifier functions to instantaneously key itself on and off with the sound intended for transmission; annoying effects of undesired background noise and off-microphone pick-up are thereby minimized. Freq. response is maintained within 1db. for freqs. between 50 and 15,000cps; distortion under 1%; noise is 60db. below + 8 VU output level. The unit is designed for standard rack mounting, 3¼ in. panel space required. Ron Electronic Corp., 150 Pine St., Montclair, N. J.

Circle 186 on Inquiry Card

## CONNECTOR

*It joins flat conductor cable to round wire.*

For military and O.E.M. applications, this device can connect up to 42 round wires to flat conductor cable in a matter of seconds. Elimination of 1 connector joint at each conductor promises up to 30% increased reliability. Terminals are attached to round wires and snapped into the female receptacle. Designed for pull-out drawers, door hinge and quick disconnect applications, it functions well under a wide range of environments. The Thomas & Betts Co., 36 Butler St., Elizabeth, N. J.

Circle 188 on Inquiry Card

## COAXIAL BANDPASS FILTERS

*Wide turning range units cover from 0.9 to 8.0GC.*

Seven basic models provide selective tuning over an extremely wide freq. range through 3 cavity gang-tuned structure. Characteristics of the model covering the 1.7 to 2.4 GC are: Type N input and output connectors; Single tuning control through 40 turn calibrated dial; Nominal 3db. bandwidth, 12mc.; Rejection at $F_o \pm$ 40MC., 40db. min.; Insertion loss, 1.5db. max.; and Input VSWR, 1.50 max. Special units available upon request. Waveline Inc., Caldwell, N. J.

Circle 185 on Inquiry Card

## TANTALUM CAPACITORS

*Non-polar solid units come in 40 ratings and 4 miniature case sizes.*

They are designed for ac circuit operation where no direct voltage bias exists; fluctuating dc polarity circuits; and dc circuits having superimposed ac ripple. Designated Type STAN, ratings ranging from 0.016 to 165μf at 120CPS., 25°C amb. Max. peak voltage ratings range from 6 to 35v. for continuous operation at temps. from −55 to +125°C, with linear voltage derating to 67% above 85°C. Rectifier-Capacitor Div., Fansteel Metallurgical Corp., N. Chicago, Ill.

Circle 187 on Inquiry Card

## RADIO FREQUENCY CHOKES

*Meet or exceed the specs. of Mil-L-LT-7K.*


Known as the 2960 Series, these new chokes range in fixed inductances from 0.15 μh to 27.0 μh. Each unit is encapsulated in epoxy resin to provide environmental protection and mechanical stability, and are color coded for easy identification of inductance values. Typical applications include instrument and control equipment, directional finders, and transmission and receiving equipment. Cambridge Thermionic Corp., 445 Concord Ave., Cambridge 38, Mass.

Circle 189 on Inquiry Card

# New Products . . . for the Electronic Industries

## DEMAGNETIZER

*Completely erases tape on the reel without rewinding.*

It produces complete erasure of recorded signal on all brands of tape and ¼ in., ½ in., or 16 and 35 mm. magnetic sound film on plastic or metal reels of any size from 5 to 15 in. Features of this "Magneraser" include: a momentary push-button control safety on-off switch; size, 2½ x 4 in.; weight 2½ lbs. Available in 2 models: Magneraser Model 200C for 100-130v.; Model 220C for 200-260v. Amplifier Corp. of America, 398 Broadway, New York 13, N. Y.

Circle 218 on Inquiry Card

## DISC BOLOMETERS

*These broadband units available in 4.5 or 8.75ma. bias current values.*

They feature non-tarnish, corrosion-resistant gold electrodes for max. stability; matched 100Ω Wollaston wire elements; and a max. VSWR of 1.5. The wire elements are series-mounted on a prepared mica base to present a 200Ω resistance to external dc or a-f bias circuits. Microwave power levels of 0.01 to 10mw. may be measured with the 8.75ma. disc and levels of 0.01 to 3mw. may be measured with the 4.5ma. type, depending upon the power bridge used. Filmohm Corp., 48 W. 25th St., New York 10, N. Y.

Circle 191 on Inquiry Card

## ZENER DIODES

*Their uses includes Limiters, clippers, voltage regulators/references.*

This line of subminiature glass diffused Zener diodes can be supplied with 2%, 5%, 10% and 20% voltage tolerances for a variety of circuits. All range from 5.9 to 300 volts in 400 milliwatt ratings at temperatures ranging from −55 to +150°C. American Semiconductor Corp., 2940 N. Kilpatrick Ave., Chicago 41, Ill.

Circle 192 on Inquiry Card

## INVERTER

*Emergency power 750va from 120, 130, or 140vdc source.*

Designed to supply emergency power to microwave relays, early warning stations, lighting facilities, and electronic control devices. Operating from reserve battery sources of 120, 130, or 140vdc to supply up to 750va of 115vac CPS. It is capable of full load from standstill within 50msec after application of dc power to the unit by a control circuit. Cornell-Dubilier Electronics Div., Federal Pacific Electric Co., 118 E. Jones St., Fuquay Springs, N. C.

Circle 193 on Inquiry Card

## C-BAND OSCILLATORS

*They measure ⅞ x 2½ and ⅞ x 2 in.; weigh 3¼ and 3 oz. respectively.*

Type 9127C (CW) will tune the entire C-Band from 5.2 to 6.0GC. by adjusting a screw on one end of the C-Band cavity. The power output is more than 10mw. from 5.4 to 5.9GC. and greater than 5 mw. over the entire band. Type 2970 (CW), illustrated, is ½ in. shorter than 9127C (CW) and weighs only 3 oz. Other specs are identical. Trak Microwave Corp., 5006 N. Coolidge Ave., Tampa, Fla.

Circle 194 on Inquiry Card

## ELAPSED TIME COUNTER

*It is also a Digital Read-out Clock with an accuracy of 0.1%.*

Features are: digits in the clock can be reset individually by independent front panel reset controls, large ⅝ in. digits on the 12 hr. clock and 5/16 in. digits on the 24 hr. clock; calibrated rotating visual 1 rpm sec. wheel; clock movement shock resistant to withstand shock of 2000 lbs./n. Available in 4 models: resettable; counter and motor enclosed; independent time counter control switch; and jewel light panel indicator. Pennwood Numechron Co., Electronic Timing Div., 7249 Franks-town Ave., Pittsburgh 8, Pa.

Circle 195 on Inquiry Card

# THE TAPE THAT CHANGED TV FOR ALL TIME

*leads you right to rugged*
*SCOTCH® BRAND Heavy Duty Tape*


THE TIE that binds television's top performer to instrumentation tape is strong—and it goes beyond the fact that the same expert team produces the best of both. "SCOTCH" BRAND Heavy Duty Tapes share a common heritage—and uncommon endurance—with "SCOTCH" BRAND Video Tape, the tape that puts a network TV show on the same "clock time" from Maine to California.

Similarities worth noting between the two: a similar high-temperature binder system, famous "SCOTCH" BRAND high potency oxides, a similar ability to resist tremendous speeds, pressures and temperatures while providing high resolution.

Let's look at the record of "SCOTCH" BRAND Video Tape and see what message it has for the user of instrumentation tape. On a standard reel of video tape like that shown here, some 1½ million pulses per second must be packed to the square inch—on a total surface area equal to the size of a tennis court. The tape must provide this kind of resolution while defeating the deteriorating effects of high speeds, pressure as high as 10,000 psi and temperatures up to 250°F.

The fact is that video tape must be essentially perfect. And it's a matter of record that thus far only the 3M experts have mastered the art of making commercial quantities of video tape that consistently meet the demands of the application.

Significantly, the high-temperature binder system developed for "SCOTCH" Video Tape is first cousin, only slightly removed, to that used in the Heavy Duty Tapes. It's this special feature that has given Heavy Duty Tapes their exceptional wear life.

The moral emerges: for tape that provides the best resolution of high and low frequencies under the severest conditions, turn to "SCOTCH" BRAND Heavy Duty Tapes 498 and 499.

They offer the high temperature binder system, plus the same high quality and uniformity that distinguish all "SCOTCH" BRAND Tapes. As the most experienced tape-makers in the field, 3M research and manufacturing experts offer tape of highest uniformity—from reel to reel and within the reel. Check into the other "SCOTCH" BRAND constructions: High Resolution Tapes 457, 458 and 459; High Output Tape 428; Sandwich Tapes 488 and 489; and Standard Tapes 403 and 408.

Your 3M Representative is close at hand in all major cities. For more information, consult him or write Magnetic Products Division, 3M Co., St. Paul 6, Minnesota.



**SCOTCH BRAND MAGNETIC TAPE**

FOR INSTRUMENTATION

**Magnetic Products Division 3M COMPANY**

# New Products . . . for the Electronic Industries

## MIL-STD 202B PROGRAMMER

*Provides control at 3 points per MIL-STD 202B, Method 102A and 107A.*

The programmer will start on the cold cycle and control at any temp. below 0 to −75°C holding the temp. for up to 3 hrs. The cycle then heats the chamber up to +25°C and holds for 15 min., then heats to any high temp. from +50 to 315°C and held for the same period selected for the cold cycle. The chamber is then cooled down to amb. +25°C and held for 15 min. Sensing is by a thermocouple placed in test area. Delta Design, Inc., 3163 Adams Ave., San Diego 16, Calif.

Circle 196 on Inquiry Card

## VACUUM SYSTEM

*SEL 823 extends vacuum into $10^{-9}$, $10^{-10}$ mm Hg region.*

Model SEL 823 is designed for routine $10^{-9}$, $10^{-10}$ mm Hg vacuum operation. This system is suited for advanced thin-film deposition techniques. Ports are supplied for mounting of optional accessory equipment, such as electron beam source, evaporant wire feeds, pusher shaft mechanical motions, r-f induction coils, sample holders, and water cooling lines. Scientific Engineering Laboratories, Inc., P.O. Box 607, Woodland, Calif.

Circle 197 on Inquiry Card

## STANDING WAVE AMPLIFIER

*Transistorized, portable unit features accuracy of ±0.05 db.*

This ±0.05 db accuracy holds true for both the full scale meter movement and for each 5 db step on the range switch. The B813T is designed for use on battery power for applications in the field or in the laboratory where line noise might cause inaccuracies in measurement. It can also be operated from the line. Calibrated range is 75 db. It has battery voltage checking and self-contained charging. FXR, Div. of Amphenol-Borg Electronics Corp., 25-26 50th St., Woodside 77, N. Y.

Circle 198 on Inquiry Card

## COMPUTER DIODE

*Typical conductance 100 ma at 1 v., recovery time less than 2 nsec.*

SD-150 is a silicon planar, epitaxial, apssivated diode in a conventional subminiature glass diode package. It is designed for use in very high speed computer circuits and for general purpose use. General Electric Co., Semiconductor Products Dept., Kelley Bldg., Liverpool, N. Y.

Circle 199 on Inquiry Card

## TRANSISTOR SERIES

*For industrial communications from dc to 100 MC.*

A complete line of DALMESA transistors, the 2N2188 series, are germanium alloy diffused mesa units characterized by min. $BV_{CBO}$ and $BV_{CES}$ for the 2N2188 and 2N2189 at 40 v., and 60 v. for the 2N2190 and 2N2191. The low, low-freq. noise corner and high alpha cutoff freq. offered by these transistors result in low-noise performance over a very wide bandwidth. Typical mid-freq. noise figure is less than 2 db. Max. power dissipation is 125 mw at 25°C amb. Texas Instruments Incorporated, P. O. Box 5012, Dallas 22, Tex.

Circle 200 on Inquiry Card

## PHOTOMULTIPLIER

*Typical uses are computers, punch-card sorting and well logging.*

This 4 in. photomultiplier, Type WX 4582, has ruggedized construction enabling it to be used under severe environmental conditions of shock and vibration. The photocathode of this tube has an S11 spectral response, peaking at 4400Å. With 105 v. applied/stage, the average anode sensitivity is 9 a./lumen and the cathode sensitivity is 50 μa/lumen. Dark current under these conditions is generally less than 0.01 μa. Westinghouse Electric Corp., Electronic Tube Div., Elmira, N. Y.

Circle 201 on Inquiry Card

# New Products . . . for the Electronic Industries

## WIDE BAND DC AMPLIFIER

*Low level "FIFO" (floating input—floating output) has 10 KC bandwidth.*

Intended for amplifying high freq. data from wide bandwidth transducers, transistorized unit may be used for many channels of commutated information at the amplifier input. Performance specs of the Model 860-4000 "FIFO" amplifier include ±0.1% linearity, gain of 1000 (10 mv in gives ±10 v. out across 1000 Ω floating; optional model can deliver ±5 v. at ±100 ma at ground potential), 100 meg. input impedance min. at dc, overload recovery time less than 1.0 msec., high common mode rejection, low noise and low drift. Sanborn Co., Industrial Div., 175 Wyman St., Waltham 54, Mass.

Circle 202 on Inquiry Card

## 450V PULSE GENERATOR

*Provides 300 to 450 v. up to 250 ma for modulating microwave amplifiers.*

Designated Model 5-6826P, this pulse generator may be internally modulated at repetition rates adjustable from 10 to 10,000 pps or externally triggered with a 20 v. peak pulse. Pulse duration is adjustable from 1 to 12 μsec; rise and fall time is better than 0.5 msec. Sync out pulse is provided. Alfred Electronics, 3176 Porter Dr., Stanford Industrial Park, Palo Alto, Calif.

Circle 203 on Inquiry Card

## POWER RELAY

*It is capable of exceeding 5 million operation with 4PDT, 15a. contacts.*

A heavy current switching or multipole relay, type 136, (up to 24 contact points) for either ac or dc circuit switching is offered. A wide, friction free, coined and broached knife-edge armature hinge assures this long life. Ease of mounting and making connections adapts this relay to individual installations or mass usage in assembly line production. Protective covered, hermetic sealed, or plug-in units are available. TELEX/AEMCO, 10 State St., Mankato, Minn.

Circle 204 on Inquiry Card

## FEED-THRU PLATES

*Electrical feed-thru plate is for vacuum chamber use.*

These plates feature solder mounted hermetic receptacles specially designed to meet the specs. and requirements of particular chamber applications. The connectors are thru-bulkhead types with combination compression glass and machined Teflon® inserts provided in a wide range of insert configurations including coaxial contact arrangements. Connector shells are machined of stainless steel. The Deutsch Co., Electronic Components Div., Municipal Airport, Banning, Calif.

Circle 205 on Inquiry Card

## VARIABLE DELAY LINE

*Type 301-S104 weighs 1⅛ oz.; range: 0-25nsec. ±10%.*

In addition to the narrow-range feature, the line affords a resolution of 0.06nsec. and a pulse rise time of approx. 2.4nsec at max. delay. Precious metal wire is used in a distributed winding to assure reliable contact, and shielding is incorporated to minimize capacitive coupling between the input and output terminals. Characteristic impedance of the delay line is 200Ω ±20% and the dc resistance is 5.5Ω ±20%. Size: 1¾ in. dia., length 15/16 in. General Radio Co., W. Concord, Mass.

Circle 206 on Inquiry Card

## VTVM

*Measures ac/dc voltages to 1500 v. and resistance 0.2 to 1000 megs.*

The Model 222 is available in both kit and wired form. It features calibration without removal from cabinet, electronic overload protection (plus fuse) 1% ceramic resistors throughout, and zero center scale. Input impedance is 11 megs. on dc, 1 meg. on ac. Voltage ranges are: 0-3, 15, 75, 300, and 1500; freq. response is 30CPS. to 3 MC.; freq. up to 250MC can be read with EICO's PRF probe. Electronic Instrument Co., Inc. (EICO), 33-00 Northern Blvd., L. I. City 1, N. Y.

Circle 207 on Inquiry Card

# New Products . . . for the Electronic Industries

## FUSED QUARTZ

*Alumina and boron content lowered using domestic raw materials.*

Fabrication of the quartz into tubing and rod is now underway. Because of its high purity, the quartz has higher thermal resistance, enabling it to withstand high temps. for longer periods of time. Tests show that the new material will deform at less than ½ the rate of the former quartz at temps. of 1200°C and higher. Price of the improved new material Type 204-A is the same as that of the previous standard line. General Electric Co., Lamp Glass Dept., Nela Park, Cleveland 12, Ohio.

Circle 160 on Inquiry Card

## SILICONE RELEASE AGENT

*Combines high release efficiency and compatibility for paints, etc.*

Dow Corning 230 Fluid, or its water-dilutable dispersion, Dow Corning 231 Emulsion gives: clean, easy release of rubber and plastic parts; and requires no unusual cleaning operations prior to painting, bonding, or coating parts released from molds or patterns coated with the new silicone release agent. Dow Corning 230 Fluid and 231 Emulsion are now in use as release agents for industrial rubber parts and plastic laminates. Storage stability is excellent. Dow Corning Corp., Midland, Mich.

Circle 162 on Inquiry Card

## EPOXY ADHESIVES

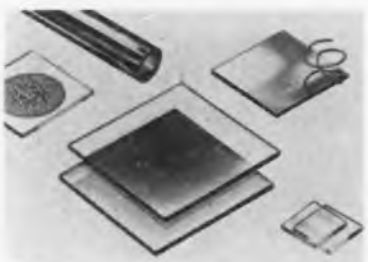
*These modified adhesives offer high shock resistance and ductility.*

The 2 one-component epoxy resin base adhesives provide higher impact, peel and bend strengths than normally attainable with epoxy resin adhesives and will not run or flow on vertical surfaces during heat curing operations. Designated SCOTCH-WELD Brand Structural Adhesives EC-2086 and EC-2186. Designed for bonding structural, metal and plastic parts, with high strength from —70 to 200°F. Adhesives, Coatings and Sealers, Div., Minnesota Mining and Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.

Circle 164 on Inquiry Card

## EVAPORATED COATINGS

*Vacuum deposited films in millionths of an inch controlled to ±5%.*



They can be uniformly applied on plastic, metal, glass and ceramic. In addition, low vapor pressure materials not formerly available for coatings can now be deposited on surfaces previously considered beyond the scope of vacuum coatings. This is possible through the use of an electronic monitoring system which measures as little as 100 Å and the development of thin films compatible with organic substrates. Evaporated Coatings, Inc., Huntingdon Valley, Pa.

Circle 161 on Inquiry Card

## ROSIN-CORE SOLDER

*Flow increase of 33⅓% gives greater wetting and reliability.*

This property insures greater reliability of solder connections and more joints/lb. The increased flow is the result of the special way the solder is processed from virgin tin and lead. It consists of a solder wire center core coated with flux, then covered with an outer sleeve of solder. Available in all alloys of tin-lead and may be had in tin-lead-silver for soldering silver-fired ceramic parts. It meets Federal Specs. QQ-S-571C. Alpha Metals, Inc., 56 Water St., Jersey City 4, N. J.

Circle 163 on Inquiry Card

## LAMINATED PLASTIC

*General purpose punching grade meets NEMA specs. for X and P grades.*

Designated 11601, the warm-punch grade of phenolic-paper composition is reported to be competitively priced for the high volume, punched insulating parts markets. It has high flexural strength, dimensional stability and uniformity from batch to batch. Available in 3 colors, natural, black, and chocolate, and in thicknesses from 0.020 to 0.150 in. Standard sheet sizes are 36 x 72, 36 x 48, and 36 x 36 in. General Electric Co., Laminated Products Dept., Coshocton, Ohio.

Circle 165 on Inquiry Card

# ELECTRON TUBE NEWS from SYLVANIA

## Eliminate optical systems in coding data...

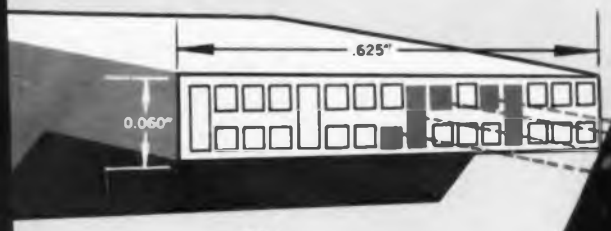



FIG. 1



FIG. 1
"Bit-'n-Bar" matrix features compact display area, only 0.060" x .625", with 24 bits and 4 bars. Film is calibrated by direct contact printing.



## New! Panelescent® EI Devices for photo-recording

**Sylvania electroluminescent devices** can be successfully used in movie cameras to *calibrate time on each frame of film*. Significantly, this is accomplished by *direct contact* printing, eliminating costly, space-consuming optical systems. Pinpoint-positioning of light output for high definition is obtained by means of a transparent conductor that confines light to desired paths. Power requirements are negligible; life attainment is outstanding.

**This is but one of many unique applications** that illustrate the practical capabilities of electroluminescence. Present devices – 10-digit multinumerics, binary dot or "Bit-'n-Bar" matrices – are flat, ultracompact. Convex, concave or cylindrical devices also are feasible. Since graphic arts techniques are used to produce electroluminescent displays, the variations in patterns are limitless.

**If you are working on similar applications,** such as instrumentation equipment, Panelescent devices can aid your design. Look into its many advantages and see for yourself. If you need assistance, call on your Sylvania Sales Engineer. For technical data, write Electronic Tubes Division, Sylvania Electric Products Inc., 1100 Main Street, Buffalo 9, N. Y.

®Registered trade mark

FIG. 2
SD114, ten-digit ¼" multinumeric. With all segments lighted each numeric draws only 5mW. Sylvania can also produce alphanumerics and symbols.

Fig. 3
SD104, triangular binary dot matrix. Dots are only .030" in diameter. Total power consumption for the matrix is approximately 3mW.


Few reliability studies hold such great import for national security as those investigating radiation effects on electronic components. Will, for example, electronic components withstand continuous radiation from the reactor of a nuclear-powered craft?

Intense radiation is known to have catastrophic effects on solid-state performance. How, then, do you design for reliable, compact circuitry without imposing prohibitive weight penalties of massive shielding?

One good way: design around radiation-resistant Sylvania Gold Brand Subminiature Tubes! All Gold Brand Subminiature types are rated for steady state radiation resistance. Extensive testing proves them capable of withstanding $10^{13}$ neutrons/sq. cm./sec. dose rate for a total dosage of $10^{16}$ neutrons/sq. cm. Further, Gold Brand Subminiature Tubes tolerate pulses of pure gamma radiation of approximately $10^{6}$ R./sec. Compare this with the gamma dose rate of 0.1 R./sec. absorbed ¾ mile from a 20KT bomb—it's well within the operating capability of Gold Brand Subminiature Tubes.

Vacuum tubes are compatible not only with nuclear environments but extreme shock and excessive temperatures. Extended periods of storage, too, have little or no effect on vacuum tubes. Ask your Sylvania Sales Engineer for complete information on the many remarkable capabilities of electronic tubes. He can supply you with detailed documentation of Sylvania Gold Brand Subminiature Tube reliability.

# SYLVANIA

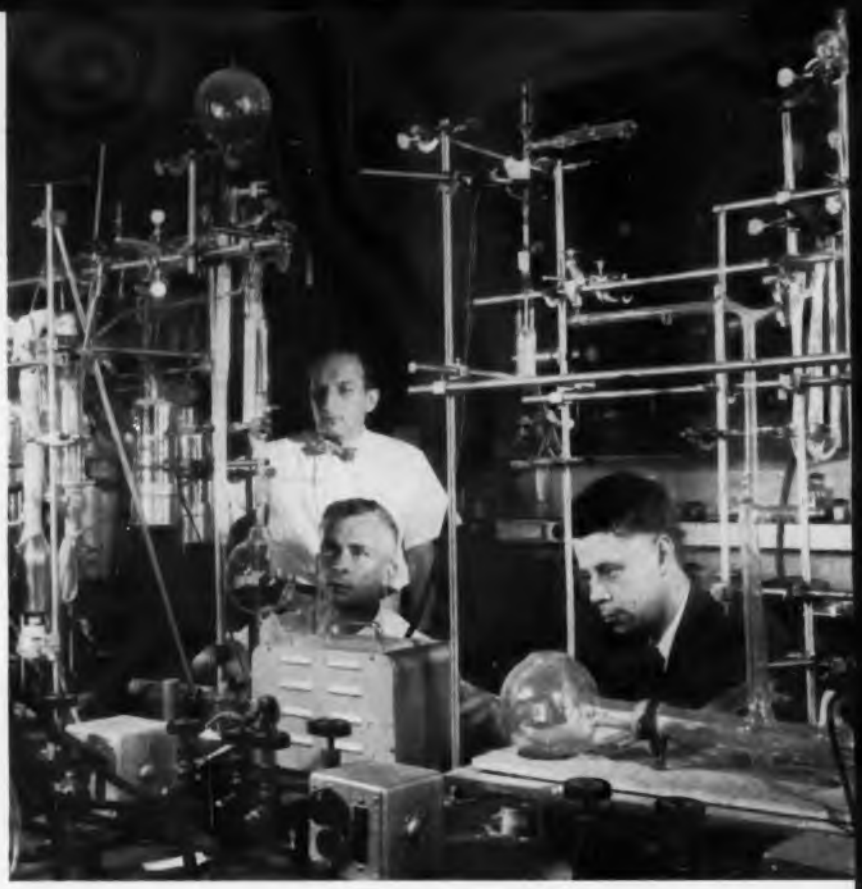
SUBSIDIARY OF

**GENERAL TELEPHONE & ELECTRONICS**

GENERAL TELEPHONE SYSTEM

P-1775

COVER STORY



At Bell Labs. scientists H. Reiss, J. J. Lander and D. G. Thomas analyze the effects of hydrogen dissolved in semiconductor materials.

**E. I. Special Report**

# Electronic Materials, Now and in the Future

***Within just the past two years there has been a new comprehension of the inherent electrical properties of materials. Stemming from the science of solid-state techniques a deeper appreciation of the behavior of the electron and its reactions to its environments has been acquired. We now know that it reacts to pressure, strains, or molecular and crystalline structures, and that it reacts to temperature changes, or to a degree of light.***

IT is remarkable that the radio, cathode ray tube, and a thriving electronics industry became established before physicists had really begun to understand the properties of metals.

The first nuclear bomb was exploded before any laboratories had devoted full-scale research to these studies. The fascination of phenomena in electronic and nuclear science had attracted far more of their time than understanding familiar materials.

Our knowledge of metals has increased comparatively little in the last 6,000 years. Metallurgists had developed their art to produce better physical strengths, but up to twenty years ago nobody knew why the addition of another metal to a pure metal increased its strength. It was the study of nucleonics and electronics which brought about the present interest in the properties of metals and other materials, and unveiled a few of the mysteries of the nature of metals.

Within just the last two years there has been a new comprehension of the inherent electrical properties of materials. Stemming from the science of solid-state techniques a deeper appreciation of the behavior of the electron and its reactions to its environments is taking place. We now know that it reacts to pressure, strains, or molecular and crystalline structures, and that it reacts to temperature changes, or to a degree of light.

To study its behavior requires the most elaborate equipment and the inexhaustible patience of our finest intellects, yet the final device to provide its control is often a masterpiece of simplicity.

These discoveries will grow with faster and greater tempo, and future forms of design will rely on the concepts of materials instead of the concepts of circuits. The face of the art may not change overnight, but the move has begun.

In the last few years the electronic engineer has

In the Camden labs of R.C.A., scientists Mario Fornoff demonstrates use of the electron microscope, one of the major tools in materials research.

Silicone rubber materials developed by G. E. for space vehicles can withstand up to 9,000°F. Here, a 1/3-in. thick sheet protects a man's hand against a 5,000°F. oxy-acetylene torch.

## New Materials *(Continued)*

expanded his art to very sophisticated and ingenious uses of the solid-state techniques.

At the present moment he is confronted with tasks of such magnitude that he literally flows on a stream of intellectual energy to effectively apply the discoveries in the fields of physics. No sooner is one concept offered before another seeks to extend it, and the main force behind these developments is the profoundness of an electron's behavior in matter.

Very little is known about the true properties of high purity metals, and virtually nothing is known of the effect of even trace quantities of any element which has no impurities whatever. The study of absolutely pure metal elements provides one of the major investigations relating to 'new' metals, or materials.

The eventual discoveries will probably unlock the vast and final stage for applications by electronic science, but the endless search for perfection will never be ended.

The gap between the pure research of physics and electronic engineering is rapidly diminishing. The arts are blending with such close understanding that the file of unused discoveries is negligible. Comprehensions of ideas are almost immediate, and objective achievement becomes a logical sequence of research.

Cause and effect in electronics initiates a continuous analysis of matter, and at each stage of discovery a new generation of techniques is produced through equally brilliant engineering applications.

The operational medium is still the electron, in one or another of its transitions. The phenomena of its behavior is seemingly inexhaustible, and the concepts of its application challenge the engineer, as the mysteries of matter challenge the unceasing inquisition of the physicist.

To assist the electronic engineer in appreciating some of the current research on materials a broad view of the subject is presented here.

### *General Studies*

Current research into the properties of materials has provided the electronic industry with many new mediums to develop electronic science.

Research and development programs on materials are concerned with chemistry, physics, and solid state theory, electrical, mechanical, and nuclear engineering. However, the electronic engineer obtains his major benefits from solid state physics. These studies have produced transistors, masers, thin-film devices, and are constantly presenting newer materials and applications. A broad outline of these developments is summarized below.

### *Magnetics*

The active fields of research in magnetics investigates fine particle ferromagnetism, precipitating ferromagnetics alloys and ferrites. These investigations are concerned with the interactions of single domain parts; orientation effects in powders and in alloys; preparation of strong permanent magnets from powder and many other industrial uses of magnetics.

### *Band Theory*

In low temperature physics, to verify the predictions of band theory, experimental work is carried out on the band theory of metals and semi-conductors. The measurements are concerned with electronic and lattice specific heats of metals and alloys. Order—disorder effects in solid solutions and the effect of lattice distortions of almost all physical properties.

### *Superconductivity*

Investigations are proceeding in the studies of radio frequency; microwave, and infrared absorption of electromagnetic energy by thin-metal films, in the intermediate and superconductivity states.

This research on materials will provide important information concerning the feasibility of super-sensitive detectors of electromagntic energy at very low noise levels.

### *Thermoelectricity*

Alloys are investigated which produce thermoelectric

properties, and includes the study of the Fèrmi levels caused by the additions of alloying elements, which vary the thermoelectric power. This work involves the measurement of the very small Seebeck coefficients per degree Kelvin. The super-low temperatures of liquid helium applied to superconducting transformers have given sensitivities of $10^{-10}$ volts in experiments.

### *Free Electron Theory*

Electrical conductivity is the most characteristic property of metals. It is evident that the outer electrons of certain elements are only loosely bound to the remainder of the atom. When the atoms are brought together to make up the crystal lattice the loose electrons jump from ion to ion with apparent freedom.

The movement of these particles have many energy aspects. It is considered that the electrons in the atom become wave trains, which reverberate like sound in a closed space. These create stationary interference patterns corresponding to the quantum states. Whole atoms are reflected by crystals as if they were waves. From these functions these energies are expressible in terms of frequencies and wave lengths.

For engineers who have forgotten, an ion is an atom which has gained or lost one or more of its electrons, and thus has either a positive or negative charge. The reactions involving the recombination of ions play a great part in the formation of crystal structures. Imagine a metal as a gas of free electrons, moving in a uniform positive potential caused by the ions in a crystal lattice. Then imagine that any wave function involving several identical particles must change their sign from positive to negative or vice versa, when the coordinates, including the spin coordinates of any identical pair are inter-changed. When the particles of a system occupy definite quantum states, then no more than one particle can occupy any given state. Briefly, this is the Pauli exclusion principle.

Another condition is derived by electron multiplication which is created by the bombarding of surfaces by electrons. Where the electron impinges, it expels several more electrons. If these electrons are caught in an electric field, and forced against another similar surface, each of them may give rise to several electrons. From this multiplication of electron activity an appreciable electrical pulse may be obtained. All these stages of multiplication may be started by the emission of a single electron.

The behavior of an outer electron is not restricted to be bound to the immediate nucleus of an atom. The electron is free to be shared, and form a covalent bond.

The electron spin mentioned above is actually the intrinsic angular momentum of the electron, regardless of its orbital motion. The spin contributes to the angular momentum and is quantized: which means the magnitude of its potential energy expressed in a discrete set of values.

### *Band Theory of Solids*

The simple free electron theory of metals was so comprehensive that it was natural to wonder if the same ideas could be applied to other types of solids, such as semiconductors and insulators. The basic assumption of the free electron theory is that the atoms may be stripped of their outer electrons, so that the resulting ions would arrange themselves into a crystalline lattice, and the electrons then poured into the space between. However, as explained in the Pauli exclusion principle, each electron must go into a distinct state, or energy level. It can be shown that the energy levels in the lattice of ions fall into groups, or bands. In the allowed bands, the levels are so closely spaced as to form a continuum, but there are also energy gaps or forbidden bands, i.e., certain ranges of energy in which there are no levels at all. Each allowed band contains just two levels for each atom in the crystal (corresponding to the two possible values of spin) but it is possible for various bands to overlap.

The properties of the material depend on what happens when the levels are filled up, from the bottom, by the available electrons. If the number of electrons exactly fill certain bands, with a wide gap above them, the material will be an insulator. In this condition, it is difficult to supply enough thermal energy to an electron to promote it to a conduction band, where it would be free to move, and thus to carry a current. When the gap is very narrow, or when there are impurities present to create extra levels, the substance can be semiconducting. In semiconductors the electrons may be promoted from filled levels in the material to empty levels provided by the impurity, or from filled levels provided by the impurity to empty levels in the material. In a metal, there is always a partially filled band in which the electrons' behavior appears to be free. Direct evidence for the existence of bands is provided by the soft x-ray emission spectra, but the value of the theory is not so much its correctness in detail as the simplicity of the band concept in which the energy relations between various phenomena may be described.

There are a mass of complications relating to the theories of electron behavior, and this discussion is merely an aid to comprehension. As the sciences are fully engaged in solving the mysteries of electron activity no overall formula is available.

### *Electron Escape*

For an electron by its own action to escape completely from beneath a clean surface, the electron must have kinetic energy sufficient to overcome the negative potential energy barrier and to carry it through the surface; also the electron must possess sufficient energy to overcome the image force and to carry it to a region beyond the action of this force. The free electrons in a metal are often considered

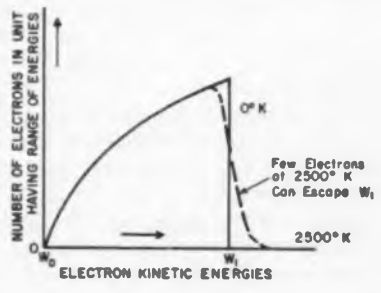



Fig. 1. At 2,500°K. some electrons have random velocities exceeding $W_1$. At 0°K. no electron can have this energy.

to constitute an electron gas within the metal. The motions of the electrons of this "gas" are studied statistically by the methods of Fermi and Dirac. The distribution of kinetic energy among the free electrons in a metal is considered to be as shown in Fig. 1.

Electron kinetic energies are plotted on the X axis, and the number of electrons in unit volume having unit range of energies are plotted on the Y axis. The total area enclosed in Fig. 1 represents the total number of electrons per unit volume. At 0°K., no electrons have kinetic energies above a value often designated $W_1$, but at some temperature such as 2500°K. (for tungsten) some electrons would have initial kinetic energies greater than the value $W_1$.

From the standpoint of electron escape, however, the important consideration is the distribution of kinetic energy directed at right angles toward the boundary surface. Only those electrons with sufficient velocity, and resulting kinetic energy, at right angles toward the surface, can pass through the barrier potentials. From statistical reasoning, Fig. 2 is developed. This figure differs from Fig. 1 in that it considers the free electrons within the metal only from the standpoint of their kinetic energies directed toward the surface. Fig. 2 indicates that many electrons have small amounts of energy (near $W_0$) directed toward the surface, but that no electrons at 0°K. have energies greater than $W_1$. This figure shows also that only relatively few electrons at 2500°K. (for tungsten) have kinetic energies exceeding the value $W_1$, such as those with energies $W_2$.

The situation may now be considered with the aid of Fig. 3, and as shown in Fig. 4. The exact location of energy level $W_0$ with respect to the potential energy humps is uncertain. Fig. 4 shows that at 0°K. no electrons can escape from the metal because none has kinetic energy exceeding the value $W_1$ necessary just to penetrate the surface forces. Thus, an insulated metal body at 0°K. would remain uncharged. If, however, the metal body is at some temperature such as 2500°K. (for tungsten), some electrons will have energies directed perpendicular to the surface as great as $W_3$, and will leave the surface, and will not return. Thus, as has been known for many years, a sufficiently hot insulated metal body will lose negative electricity.

### *Crystals*

Almost all pure elements and compounds are capable of forming crystals.

A perfect crystal is one in which the crystal structure would be that of an ideal space lattice. No such crystals exist, all real crystals contain imperfections and these have a strong influence on the physical properties of the crystal.

There are two familiar types of crystals which are used in communications work, the rectifying and the piezo-electric. Among the first may be mentioned galena, germanium, silicon and silicon carbide, and these have the property of passing current in one direction and not in the other, or in some cases unequally in the two directions. Since demodulation or detection is fundamentally a process of rectification these crystals may be used as detectors of modulated radio signals.

The electrical characteristics of crystal show interesting electron actions. The piezo-electric crystal has the peculiar property of giving a voltage across certain faces when a mechanical pressure is applied to other faces. Among crystals exhibiting this effect are Rochelle salt and quartz, the first being by far the most active but the second being much stronger mechanically. As is known, these crystals are used in various ways in communications circuits. Rochelle salt is used for microphones where the sound waves striking the crystal produce corresponding voltage which

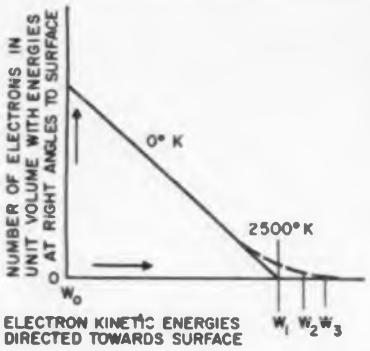



Fig. 2. Effect of temperature on the kinetic energies of electrons.

are amplified for use, for phonograph pickups where the pressure is produced by the needle linkage, for loud-speakers and headphones where use is made of the reversibility of the process, i.e., the voltage is applied and it causes the other faces physically to move. Quartz is widely used for frequency control of radio transmitters, for filters in telephone carrier circuits and for very sharp tuning in receivers. These elementary reminders are to emphasize the role that crystals have played in the development of material properties. The atom groups III of the periodic table combine with group V to form crystalline semiconducting compounds. These are known as the III-V semiconductor compounds. These chemical compounds have a 1 to 1 atomic ratio between the III and V atoms, which occupy the sides of a crystal lattice.

These atoms control their environment to the extent that if a mixture of indium and antimony is melted, the compound InSb is formed. When the compound cools to a solid the excess of either ingredient is expelled as a second phase.

As described in the previous section the outer electrons or valency electrons of an atom combine to form molecules and crystals. The III groups of atoms have one valence electron less than group IV, and the V group have one electron more. These groups form the semiconducting crystals, germanium silicon, diamond, and grey tin.

The difference between the group 1V semiconductors is that the compound crystals have a lower symmetry. Also, group IV crystals consist of convalently bound neutral atoms, but III-V compounds contain positive and negative ions at the lattice sites.

The semiconducting properties of these compounds are characterized by a very high electron mobility, and also by a small energy gap. Some of these materials

are ionic crystals, which was atomically described in the previous section.

The properties of indium antimonide are a remarkably small energy gap, and high electron mobility. It is excellent for building or growing pure single crystal formations. Often the mobility of these compounds is greater than the holes.

### *Crystals and Light*

By using a new light source called a LASER University of Michigan physicists have for the first time produced an overtone of a beam of light.

Besides being significant as a scientific achievement, the result holds important implication for communications and other applications.

This second harmonic (or overtone) of red light was produced by focusing the LASER's intense beam of pure red light into a quartz crystal. The second harmonic—a deep blue beam—was produced as a result of the extremely high intensity of the red light at this focus.

The LASER beam was monochromatic (or "pure" color) at 7000 Angstroms. The blue beam, an almost invisible violet which was considerably weaker than the LASER beam, was monochromatic at 3500 Angstroms.

To produce the intense beam, the U-M physicists used a LASER purchased from Trion Instruments, Inc. They termed the LASER "one of the most powerful in the world."

The beam produces a power density of 100 million watts per square centimeter at the focus. (By contrast, the intensity of sunlight at the earth's surface is one-tenth of a watt per square centimeter.)

Light waves are of the same substance as radio (electromagnetic) waves, but are of different frequency and wavelength—far shorter, for example, than the shortest radio waves now in use for communications.

One of the implications of the experiment is that it may open the way for using electromagnetic waves in the frequency region of light for communication purposes.

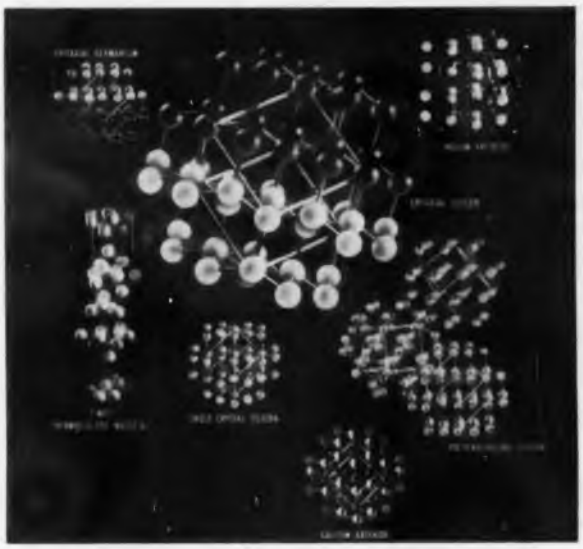
For this, the light beam must be modulated (or mixed) as are radio waves—to carry a signal. The mixing provides oscillations in the waves, the oscillations varying according to the mixing—the way the message is put on the beam.

If light waves can be used for this—and the U-M physicists point out that there are many difficult problems to be solved—beams of light would be constructed with a message carrying capacity many times that of the longer radio waves.

If these problems can be solved—a single light beam could carry all the messages that now go across country on regular communication channels.

Another application of this achievement is to permit the investigation of materials' properties that scientists haven't been able to study before—for example, the non-linear optical properties of various materials.

Synthetic ruby, which is single crystal aluminum oxide doped with chromium oxide, is being extensively used in several solid state devices, including microwave MASERS and coherent light oscillators (optical



**Molecular construction of various modern materials**

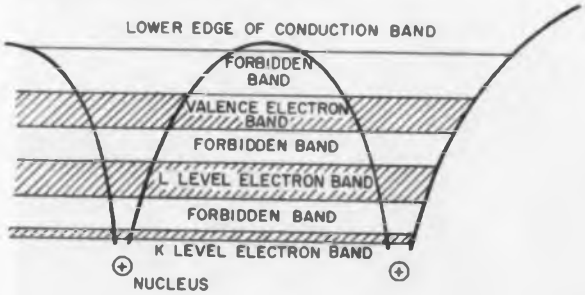
MASERS or LASERS). This bulletin describes the physical properties of LINDE synthetic ruby which are pertinent to its use in solid state applications. The paramagnetic properties of a ruby MASER material is used because of its physical, and chemical stability, high thermal conductivity, and low dielectric losses.

Several internal imperfections are discernible in ruby: fuzed layers, seed crystals necessary to control orientation, entrapped gases, and lineage. Fuzed layers are caused by incompletely melted powders pulsed onto the boule growing cap. Some optical differences are evident between the seed chromium concentration of an incompletely melted seed crystal, and the remaining crystal. Lineage, or internal orientation variation, is easily observed between crossed polaroids, and is a result of substituted chromium strain and thermal stress. Synthetic ruby is birefringent and any slight internal misorientation is exhibited by differing light refraction through a crystal. If internal strain is unusually severe, twinning and fracture can result. These internal properties exist in a ruby crystal to a varying degree. Conventional European type ruby boule has lineage variations of several degrees.

### *Refractory Materials*

A number of refractory metals and metallic com-

**Energy bands of a perfect crystal of silicon. No electrons are in the forbidden bands or atom structures. Electrons with kinetic energies are in the allowed bands. (Idealized)**



## New Materials *(Continued)*

pounds are now being grown in the form of large single crystals. The Linde Company, Division of Union Carbide Corporation has made considerable contributions to this work. A new, arc fusion crystal growing process has been developed and used to grow refractory crystals such as tungsten, molybdenum, tantalum, columbium, vanadium, titanium carbide, titanium diboride, columbium carbide, molybdenum disilicide, titanium monoxide, titanium sesquioxide, and niobium. Other substances can be produced in similar form.

The crystals are produced as cylinders in diameters of ¼ inch to 1 inch and lengths of a few inches to over a foot. Tungsten crystals ¾ inch in diameter and 12 inches long are being made. Larger crystals and other shapes can be made as the need develops.

The arc fusion process is similar in some respects to the Verneuil flame fusion process used by Linde Company in commercial production of synthetic sapphire and star sapphire, rutile and other oxide crystals. Thus, a primary advantage of the Verneuil process is retained; the fact that no container for the molten substance is required, while important process advantages are secured through the wider range of temperatures and atmospheres obtainable with electric arcs as opposed to combustion flames.

The new process was developed by scientists. Dr. G. H. Wagner, Linde's Director of Research, stated, "Inherent characteristics of these single crystals, purity, homogeneity, absence of grain boundaries and porosity, and controlled crystallographic orientation, provide a new basis for study of refractory materials and for practical development of new products and new devices.

Single crystals of tungsten are much more ductile and can be worked at much lower temperatures than presently available polycrystalline specimens produced by powder metallurgy or conventional arc welding. Experimentation with refractory metal single crystals is rapidly increasing understanding of the basic properties of these materials, and it is expected that this will accelerate availability of wrought products in useful sizes, shapes and quality. Titanium sesquioxide is a high temperature semiconductor. Titanium diboride combines in an unusual way hardness, corrosion resistance and electrical conductivity. Molybdenum disilicide has remarkably good high temperature oxidation resistance. Large single crystals of such materials provide new opportunities for determining intrinsic properties and for developing new products to solve difficult materials problems in high temperature electronics and in areas involving wear, corrosion and high temperature.

### *Organic Semiconductors*

Considerable interest has been aroused in organic semiconductors due to the possibilities of using an enormous amount of new materials for use in electronic application. At the moment, the research is in a very early stage; however, the production of these new materials may overshadow the successes of germanium and silicon as semiconductors.

Organic semiconductors are solids with a considerable number of carbon bonds which support electrical conduction. They fall roughly into:

1. the molecular crystals, such as anthracene, and
2. polymers, which are used in plastics.

It is anticipated that the electrical properties of plastics will be employed as semiconductor devices. If this can be done, the results are likely to be revolutionary, as are so many other developments in the electronic sciences. If a synthesized organic molecular structure could be made as a semiconductor with its electrical properties controlled, the advantages for electronic devices would be limitless. The way in which organic materials conduct electricity is through the phenomena termed "overlap," which is

**Both pictures at the left are 60,000X transmission micrographs showing image detail contained in the electron beams that produce two of the spots in the diffraction pattern at right.**

*(Photos—General Electric)*

actually that area where the paths of the different electrons of molecular structure intersect. In the right conditions, the movement of the peripheral electrons may be drawn into association with electrons of another molecule. The activity of these electrons flowing from one molecule to another develops a means of electrical conduction. The calculations for these movements in anthracene provided a means to determine the paths of the electrons. The course of the peripheral electrons of anthracene molecules indicated the possibilities of overlap.

Finally, the direction of the electron overlap was predicted, which had made this electrical conduction possible. The findings of the investigation were remarkable, considering that inorganic techniques were used on an organic material, and despite the fact that the bonding between the molecule and anthracene is quite different from that of germanium and silicon.

The purity in semiconductors is very important because the impurities in inorganic semiconductors actually carry electrical current. These impurities are very small, sometimes less than .001 of one percent of silicon.

From an information point of view, it is obvious that organic chemists and physicists much re-orient themselves with each other's work. As the physicists and chemists have different vocabularies in discussion of the same phenomena, it is necessary to establish a sound communication of their ideas, and to write their findings in a manner which is comprehensible to electronic engineers.

It is possible that there are electrical properties in many of the compounds, and it is hoped that the scientists in these fields will be able to make theoretical models of organic compounds to achieve these ends. There are 900,000 separate organic compounds now classified. The problem of deciding the precise compound that will show the best results through research is becoming a serious difficulty.

The future of orangic semiconductors is uncertain as the study is complex and extensive. Electrical conductivity in polymers and plastics will have to be better understood before the future concepts can be visualized; but to anticipate the future, it may be possible to produce paints which would be semiconducting. The sun's rays on an exterior of a house may have the radiant energy converted to electricity and thermo-electrical effects may enable walls on the inside to be cooled or heated from these collected energies.

### *Metals and Semimetals*

Antimony and bismuth are semimetals under study at the present time in applications for low current switches in computer networks. In semiconductor devices produced with these materials the flip-flop type switches can operate theoretically in a billionth of a second.

Such switches are still in the experimental stage, but when the products are finalized they will reduce operating costs, and considerably improve computer designs.

Semimetal regulators operate at super cold temperatures in the cryogenic range at roughly 450 degrees below Fahrenheit. The electron energies at 0°C are still as strong as before, but the shell electrons do not escape. The electrons have a stronger tie with other electrons.

### *Pure Iron and Magnetic Devices*

Recent research at the Franklin Institute in Philadelphia indicate that the permanent magnet of the future may be made of pure iron.

The two significant properties in this evaluation are the coercive force ($H_c$) and energy product ($BH_{max}$). In general, the higher these factors are the better the magnetic strength. Energy products of 40 million with coercive forces ranging up to 10,000 oersteds seem feasible.

Normally, commercial magnetic steels range in coercive force from about 40 to 170 oersteds. Higher permanent magnet alloys run to 500 to 1400 oersteds, and slightly higher. The energy products average one to five million in presently available materials.

The magnetic particles in the form of powdered iron may be mixed with binders to increase the mechanical strength of the product, or to prevent oxidization. The magnets are produced by compacting the powder in dies under 10,000 to 200,000 psi. No sintering, melting, casting or heat treatment is needed.

### *Silicon Carbide*

The Westinghouse Corporation has been successful in producing the first transistor capable of operating over 650°F.

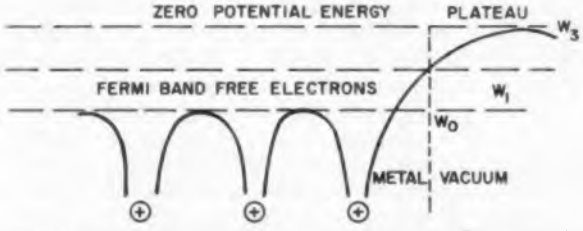



Fig. 4. The electron can only escape the metal when it has enough potential kinetic energy to pass through the $W_0$ plateau.

The desirable electrical properties at elevated temperatures and its high chemical stability have made Silicon Carbide a promising material for extremely high temperature operations.

Normally the highest temperatures for present day transistors is in the region of 400°F for a silicon type unit. Experiments with the silicon carbide transistor under development showed that it is effective up to 670°F, and it is hoped that this figure will be raised to 925°F.

The development of this unipolar type transistor was made possible through two important advances: the recent availability of silicon carbide crystals of exceptional purity, and the perfection of techniques to form the semiconductor junction in the material, i.e., the development of ways to clean, etch, solder and otherwise handle the inert silicon carbide crystals.

The silicon carbide transistor is made from crystals about 2 mils thick. These crystals have an impurity content of less than one part in 10 million. The semiconductor junction is built into the material by exposing it to vaporized aluminum at 3900°F. At this temp. the aluminum atoms diffuse into the silicon carbide,

## New Materials *(Continued)*

changing its electrical behavior from n-type to p-type. The junction is formed where the two types meet, and the diffusion process is controlled to within a few millionths of an inch.

To construct the input and output terminals of the transistor, the wafer is etched at two points until the junction within the body of the crystal is reached. Electrical connections at these two points and to the body of the wafer complete the transistor. A typical finished transistor is about 80 mils long and 40 mils wide, and the "working" area of the crystal surface is smaller than the head of a pin.

### *Low Temperature Materials*

The following discussion deals with some of the recent developments in electronics using low temperature, or cryogenic regions of operations. The fields include crytrons, cryosars, MASERS and LASERS.

At temperature approaching absolute zero, electrical conductivity of certain materials increases to very high values. A brief description of cryogenic developments will clarify the position for understanding some of the recent research in this field. The subject of cryogenics is concerned not only with the attainment of low temperatures but also with the techniques for making measurements and conducting investigations in these areas. There are commercially manufactured cryostats, which are special test devices designed to conduct super-low temperature research. These machines can maintain any tmperature in the 0.25 K. to 1.0 K. range.

Another device used is the cryotron, which utilizes the fact that the super conductive transition depends upon temperature as well as the electromagnetic field. In operation, the effect of these transitions can be observed in the cryotron. For example, when a straight wire is placed inside a coil of different material and cooled to its superconductive temperature, the straight wire becomes superconducting, and a very small voltage is sufficient to cause a persistent current to flow in it. If another current passes through the coil, its surrounding magnetic field changes the superconductivity of the straight wire and the current ceases. Some of the materials used in these applications were Tantalum and Columbium or Niobium. The small size of these devices made them practical for use in computers as switches, and their extremely low operating current provides another great advantage for use in computer development; however, the present application is limited due to the size of the refrigeration unit required to operate the device.

Electron microscope enlargement of latex polystyrene
*(Photo—Franklin Institute, Phila.)*

### *Thermoelectric Materials*

Thermoelectric materials are metals having the properties of transferring electrical energy into controlled temperature changes at the junction of two dissimilar conductors.

The Peltier effect may be described as the reversible transformation of electrical energy and heat, at a junction of dissimilar conductors. Given a junction of materials A and B, when current flows from A to B there will be a rise in potential across the junction and heat will be absorbed.

The Peltier coefficient depends on the materials of the junction, and the temperature of the junction, but it is independent of other temperatures in the circuit. The Thompson effect may be defined as the reversible transformation of electrical potential energy and heat, due to a finite temperature gradient in any single conductor.

Both the Peltier and Thompson effects are reversible; therefore, any junction of dissimilar materials used as conductors, or any portion of a conductor in which there is a temperature gradient, constitutes a source of electromotive force. In a complete circuit the sum of these emf's is known as the Seeback emf of the circuit, or the thermoelectric force.

Thermoelectric experiments using Tellurium, Bismuth and Antimony have produced the most desirable results, though other materials have recently shown great promise from the mass production point of view.

As the thermoelectric effect is mainly a materials problem or phenomena, it is desirable to have a "figure of merit" which characterizes the potential of various solids. Considering that the thermoelectric effects can be used for either heating, cooling, or the generation of electricity, the calculation of this "figure of merit" can be made in several ways.

To return to the materials considerations of thermoelectrics, the validity of a "figure of merit" is an indication of a materials usefulness in practical applications. The material requirements are stated in the form of specific objectives. Principally one requires high thermopower, high-electrical conductivity, and low-thermal conductivity. These objectives have generated the development of materials not normally considered to be metals.

In the ratio of thermal to electrical conductivities there are three parameters to consider as the thermal conductivity is a sum of electron and lattice conductivity. In pure materials, and perfectly homogeneous alloys the minimum thermal conductivity is represented by the lattice contribution. Since this is obtainable only with zero charge carriers, which would mean zero electrical conductivity, there has to be some electron contribution. In order to have a maximum of $\sigma$ to k, relatively few carriers are needed, but very high mobilities, plus a low lattice conductivity.

**Model of the arrangement of atoms in silicon is the background for refined silicon (1.) and various ingots. Transistor is at right** (Photo—Bell Laboratories)

### *Practical Applications*

American development has not yet reached the point to apply thermoelectric developments to the domestic appliances. It seems the Russians have produced a domestic type refrigerator for the consumer market. R. C. A. has produced several appliances, including a small room thermoelectric air conditioner, and an experimental refrigerator, with ice maker unit.

It is estimated that devices with a "figure of merit" of unity, or slightly larger would be feasible for nearly all types of refrigeration and air conditioning.

An F.O.M. of roughly the same magnitude would make thermoelectric generation practical for consumer use in specialized cases; e.g. aircraft; radio, and television applications. An F.O.M. several times larger would be required to make commercial power production competitive. However, wherever a large amount of waste heat is available, several possibilities may present themselves for thermoelectric applications.

A great deal of the current research has been conducted by Franklin Institute in Philadelphia. In the coming year basic research on materials will be intensified. The goals of the program are to derive and analyze the basic theory of the behavior of thermoelectric materials, and to do research on the physics of semiconducting compounds, particularly their thermoelectric and energy transport properties. (A more detailed description of thermoelectric theory was presented in E. I. July 1959 issue.)

### *Cryogenic Developments*

The art of cryogenics is comparatively young, and many of the causes are not fully understood regarding the phenomena of low temperatures. As the temperature nears zero, the random motion of electrons, atoms and molecules becomes less and less. In this condition the special effects are observed, which at present show four conditions:

1. Superconductivity.
2. Electrical resistance increase of some semiconductive materials.
3. Low thermal noise for paramagnetics materials.
4. Superfluidity of liquid helium which is as yet an unused phenomena.

### *Superconductivity*

In brief, superconductivity is the complete lack of measurable electrical resistance occurring in certain elements and alloys at temperatures approaching absolute zero. The highest temperature at which superconductivity appears at present is about 18K in a niobium-tin alloy.

Its most immediate practical use of superconductivity appears to be in switching devices, such as small high speed logic and memory elements for computers, and as amplifiers and rectifiers and cryogenic magnets. Other potential uses include frictionless bearings for motors and gyroscopes, magnetic lenses for electron microscopes, oscillators, and possible applications in power equipment.

This complete lack of resistance, or electrical friction, means that with a very low power source, current can be started in a superconductor, and when the power source is removed, the current continues to flow unabated indefinitely. The current creates a magnetic field around the superconductor which also stays constant indefinitely.

Superconductivity is affected or controlled by two parameters: temperature and magnetic field. A material's transition temperature is the temperature, below which, the material is superconductive. The "critical field strength" of a material is the strength of a magnetic field required to "quench" the materials superconductivity and return the material to its normal resistive state. The critical field strength changes in different materials, and in a superconductor it increases as the temperature decreases.

There are 25 elements and probably over 250 metal alloys and compounds now known to exhibit superconductivity at temperatures from 18 K down to near 0 K.

One of the most recent and interesting superconducting material is a niobium-tin alloy. It has one of the highest transition temperatures presently known, about 18 K. Considering that the critical field strength of superconductors increases with decreasing temperatures, the new alloy has a very high critical field strength at temperatures close to 0 K. Strengths of 100,000 gauss are within the bounds of possibility.

Niobium-tin alloy has a brittle nature, making fabrications extremely difficult. Alloys of molybdenum and technetium producing greater ductility were announced by Bell Telephone Labs. Other alloys, recently reported by Bell, include niobium-titanium, vanadium-titanium, and a niobium-zirconium alloy which remained superconducting in a field of 80,000 gauss while carrying a current of 10,000 amp/sq. cm.

The most promising development in cryotrons is the thin-film cryotron produced by deposition of thin films

of superconductive materials on a substrate such as glass which was discussed in detail in the September issue of E. I.

Uses for superconductivity include frictionless bearings, motors, and gyroscopes.

These devices are based on the "magnetic insulating" capability of superconductors. When an external magnetic field is brought close to a superconductor, it generates eddy current, and consequently a magnetic field, in a thin surface layer of the material. The latter magnetic field repulses the lines of force of the impinging magnetic field.

A bearing made of superconductive material can be supported on a magnetic flux caused by a superconductive coil. Increasing pressure on the rotor or bearing would increase the flux density and so increase the current in the coil and amplify the repelling force of the flux. In this design, a rotor or bearing would operate virtually without friction, and thus with maximum efficiency and minimum error. It must be remembered that such devices would be operating in cryogenic temperature.

Other possibilities include superconductive magnetic lenses, which when applied to an electron microscope might have such increased resolution. The atom may become visible; use of superconductive power transmission that would permit tremendous loads in a very small conductor.

### *Superconducting Magnets*

Research on superconductivity over the past two years has made rapid strides in generating very strong magnetic fields. Fields of 100,000 gauss and more can be generated experimentally over substantial volumes with negligible power. The quenching of superconductivity by the use of magnetic fields has been solved through the use of special materials, such as niobium and a compound of niobium and tin. Applications for superconducting magnets are found in electronics wherever there is a need for moderately strong fields. MASERS are one example. Even more striking, superconducting magnets could eliminate the need for thousands of gallons of cooling water and megawatts of power for the coils used with high-energy particle accelerators and research machines for research on controlled fusion.

Experimental work at the Bell Telephone Labs has been made in which a compound of three parts niobium to one part tin ($Nb_3Sn$) has remained superconducting in fields of 88,000 gauss. In 1954, as part of a wide ranging study of superconducting properties of materials, B. T. Matthias, T. H. Geballe, S. Geller and Ernest Corenzwit of Bell Labs published properties of $Nb_3Sn$. They reported it as one of the highest transition temperatures known at 17.9°K. Eventually a wire was made that sustained 88,000 gauss without loss of superconductivity, and this figure is definitely not the field limit, but it was the strongest that was available for the experiment. It is possible that a superconducting $Nb_3Sn$ coil can generate 100,000 gauss.

The first practical use of the new magnets will be on a modest scale in such electronic devices as MASERS, which operate in the same cryogenic temperatures. Within a very short period the results of this magnetic research has coincided with other work in the low temperature field and produced practical applications in current electronic engineering.

### *Gallium Alloys*

The National Bureau of Standards, in a project sponsored by the Air Force, has been studying the use of gallium-based alloys as bonding materials. These alloys can be used to fasten wires to heat-sensitive electronic devices, such as transistors, and to "cold solder" ceramic and metallic surfaces.

Gallium-based alloys can be made by weighing portions of liquid gallium (mp 29.9°C) and finely powdered metal and mixing them in a Teflon breaker. Various combinations of gallium with copper, gold, nickel, and silver were prepared and tested in this program. Tin was added to several of the gallium-copper alloys, and acted to delay the initial set. Small quantities of 0.1 gram were prepared, which was sufficient to connect several electrodes.

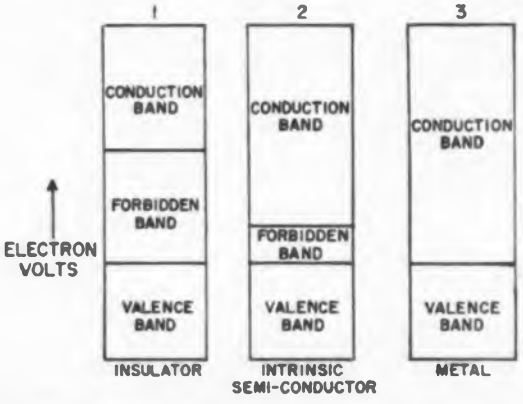



**Figure 5**

**INSULATOR:** Insulators are mixtures, not pure elements. In an insulator the valence band is packed solid with electrons. Conduction is impossible by electrons in this state, as none can move. In insulators there is a big energy gap of several electron volts between the valence band and the next higher permitted band. Because of the wide energy gap between the valence band and the conduction band an insulator must reach a high temperature before the electron bonds can be broken and raised to the conduction band.

**SEMICONDUCTOR:** Silicon and germanium are intrinsic semiconductors. Energy required to break the bonds and transfer electrons from the valence band to the conduction band require about 6 to 7 electron volts for silicon and for germanium about 0.7 electron volts. At high temperature the valence bonds can be broken more rapidly and so resistance decreases.

**METAL:** If no forbidden band exists between the filled band and the conduction band above it, the electrons may move easily to the conduction band. This would be a good conductor. In a metal atom such as copper, the valence electron has kinetic energy at room temperature and is well above the energy humps as shown in the figure; therefore, the electron can move with ease from atom to atom and is a free electron able to carry current when a difference of potential is applied to the conductor.

**REFERENCE PAGES**

The pages in this section are perforated for easy removal and retention as valuable reference material.

**SOMETHING NEW HAS BEEN ADDED**

An extra-wide margin is now provided to permit them to be punched with a standard three-hole-punch without obliterating any of the text. They can be filed in standard three-hole notebooks or folders.

## Glossary of Terms For Materials in Electronics

MASER (Microwave Amplification by Stimulated Emission of Radiation)—A means of focusing a stream of particles, which concentrates only on the high energy particles. These are passed into a resonator which is resonating at the radiation frequency of the particles. The particles are in this state raised to a strong oscillation, and can be used for control purposes. By reducing the flow of particles to the resonator, to maintain oscillations, it can be used as an amplifier. There are many other applications.

LASER (Light Amplification of Stimulated Radiation)—This is an extension of the maser principle using the same principle and extending the microwave region to the optical region. The term "Optical maser" is also used. The coherent sources of electromagnetic waves were in the 10⁴MC frequency. The optical maser has raised this limit almost 10,000 times. The potential is that by these theories it may be possible to use light as radio waves are now being used.

LATTICE—The term lattice is used to denote; a regular array of points in space, as in the case of the sites of atoms in a crystal. Lattice designs form a class of experimental designs enabling a large number of unrelated treatments to be compared in randomized blocks of reasonable size. In lattice dynamics the theory of solid state deals with the properties of the thermal vibrations of crystal lattices.

OERSTED—A unit of magnetic strength in the emu system. The magnetic field produced at the center of a planecircular coil of one turn, and of radius of one centimeter, which carries a current of $(1/2\pi)$ abampers.

GAUSS—The gauss is the electromagnetic unit of magnetic induction, which is one Maxwell per square centimeter.

## REPRESENTATIVE SEMICONDUCTORS— PROPERTIES & APPLICATIONS

| Material | Application | Melting Point F | Holes | Electrons | Band Separation (At 300 K) ev |
|---|---|---|---|---|---|
| Cadmium Antimonide (CdSb)[a] | Thermoelectric Devices | 852 | 400[b] | — | 0.5 |
| Bismuth Telluride ($Bi_2Te_3$)[a] | Thermoelectric Devices | 1076 | 400[b] | 570[b] | 0.16 |
| Lead Sulfide (PbS) | Thermoelectric Devices, Infrared Detectors | 2048 | 600 | 600 | 0.4 |
| Lead Selenide (PbSe) | Thermoelectric Devices, Infrared Detectors | 1978 | 600 | 1200 | 0.28 |
| Lead Telluride (PbTe) | Thermoelectric Devices, Infrared Detectors | 1858 | 1100 | 2000 | 0.3 |
| Indium Arsenide (InAs) | Magnetoresistance devices; Hall effect devices, thermisters | 1727 | 600[b] | 40,000 | 0.33 |
| Indium Antimonide (InSb) | Magnetoresistance devices, Hall effect devices, Thermisters, Infrared detectors, filters | 972 | 600 | 78,000 | 0.16 |
| Mercury Telluride (HgTe)[a] | Magnetoresistance devices, Hall effect devices, Thermisters, Infrared detectors, filters | 1238 | — | 17,000 | 0.08 |
| Gold-Doped Ge[a] | Infrared Detectors; filters | 1716 | 1800 | 1800 | 0.72 |
| Cadmium Sulfide (CdS)[a] | High Temp. rectifiers & Transistors; solar batteries, infrared optics, photocells | — | — | 250[b] | 2.4 |
| Aluminum Antimonide (AlSb) | High Temp., rectifiers & Transistors; solar batteries; infrared optics; photocells | 1922 | 400 | 400[b] | 1.6 |
| Cadmium Telluride (CdTe) | High Temp., rectifiers & Transistors; solar batteries; infrared optics; photocells | 1913 | 100[b] | 1000 | 1.45 |
| Gallium Arsenide (GaAs) | High Temp. rectifiers & Transistors; solar batteries; infrared optics; photocells | 2262 | 300 | 8000[b] | 1.34 |
| Indium Phosphide (InP) | High Temp. rectifiers & Transistors; solar batteries; infrared optics; photocells | 1922 | 150 | 4000[b] | 1.27 |
| Silicon (Si) | High Temp. rectifiers & Transistors; solar batteries; infrared optics; photocells | 2588 | 500 | 2000 | 1.12 |
| Gallium Antimonide (GaSb) | Rectifiers, Transistors | 1295 | 1000[b] | 3000[b] | 0.6[b] |
| Germanium (Ge) | Rectifiers, Transistors | 1760 | 1800 | 3800 | 0.72 |

[a] One compound of a family of two or more related compounds. [b] Minimum value.
Source: Willardson, R. K. and Shilliday, T. S. "The New Semiconductor Materials" Materials In Design Engg., March '58, P 114.

### *Magnetostrictive Materials*

Time delay techniques have been a problem to produce simplicity, reliability, and low costs in one design. Considerable success has been achieved with the development of magnetostriction delay line of low attenuation.

The Cossor Radar & Electronics Research of England have produced a variety of such components using nickel cobalt alloys.

For relatively short delays up to 100 μsecs the simplest construction will result if the delay media is both magnetostrictive and has good ultrasonic pulse transmission properties.

The main components of the line are the delay tube, the input transducer and one or more output transducers which are simple epoxy resin encapsulations. The transducers consist of a coil, a ferrite pot-core (which in the case of the output transducers includes a magnet) and a copper screen if short delays and close spacings are required. These transducers are made and tested divorced from the final assembly and no magnet adjustment is required at the final assembly stage.

The factors which govern the properties of delay media are discussed, in particular the manufacturing methods, the effect on magnetostriction and pulse transmission properties of the crystal structure, the grain size, texture, and stresses in the material. The physical form of the delay media was a tube 0.45 in. O.D. with 0.002 in. wall and all experiments were done using tubing to these dimensions. The materials investigated included nickel, Nilo 45 (45% NI 55 FE), and nickel cobalt alloys.

The table shows the materials investigated and some of the relevant physical properties, for nickel, Nilo 45, and nickel cobalt alloys that the random fully recrystallized material drawn by normal methods offers

Egg inside a solid ball of flexible potting compound developed for missile electronics demonstrates cushioning protection.

*(Photo—Gen'l Elec. Co.)*

## New Materials *(Continued)*

the best compromise. Apart from nickel all the materials were made by powder metallurgy techniques and were chosen for their low anisotropy and associated low temperature coefficients of amplitude and velocity.

The use of molded pre-set transducers has been developed and their use can be extended to delay lines operating in the longitudinal mode up 200 μsecs with output transducers separated by as little as 1 μsec. At the time of writing multiple output lines up to 900 μsecs long using wire as the delay media and operating in the longitudinal mode have been made.

### *Metallurgical Developments*

As long ago as 1950, the Metallurgical Director of Bell Laboratories, Dr. E. E. Schummacher stressed the vital role of minute quantities of elements added to many of the alloys used in communication apparatus, and he forecast that workers in the metallurgical research would need to strive continuously for higher-purity materials and more precise process control. Now, ten years later, it is interesting to review some recent developments to see how far to the "right of the decimal point" metallurgy has been able to go.

Today, it is possible to work at impurity levels of 50 parts per million or better which were unheard of a few years ago except for laboratory samples. Further, control of dimension within a few millionths of an inch is necessary.

Of several developments which illustrate this work, a good example is a study of a high purity magnetic material. Supermalloy, for use in cores of special transformers. This study combines the need to hold metallic impurities to less than 20 parts per million (less than 0.002% by weight) and the requirement that the final strip be rolled to a finished thickness of only 0.0002 in. within an accuracy of 10 millionths of an inch.

Supermalloy, developed in the Metallurgical Dept. at Bell Laboratories, has a nominal composition of three major constituents—nickel 79%, iron 15%, and molybdenum 5%—and two other elements present in smaller amounts—0.5% each of manganese and cobalt. The manganese is added to combine with any sulfur that might be picked up from furnace refractories or from atmospheres in heating furnaces employing oil or gas fuel during commercial processing. It was found that without the manganese, sulfur present in concentrations as low as 50 parts per million (0.005%) would make the alloy so brittle that it would break up during rolling.

Researcher at GE's Schenectady, N. Y., lab prepares to test silicone grease in vacuum chamber that simulates space conditions.

*(Photo—Gen'l Elec. Co.)*

The 0.5% cobalt is introduced as an impurity from the nickel, and there was no knowledge of its effect on the magnetic quality of the alloy. So, to get fundamental information on the properties of a Supermalloy containing neither cobalt or manganese, K. M. Olsen and P. H. Schmitt prepared a very high purity melt. They were able to control impurities to such an extent that no metallics were detected except copper and silicon (both less than 0.001%). Of the other impurities, sulfur was less than 0.001%, and carbon, oxygen, hydrogen and nitrogen were also brought to very low levels. Thus, the melt was free of cobalt and manganese, with very little impurities of any kind. By comparison, a standard, good quality melt would have an impurity level about ten times higher.

The study called for the 0.002 in. thickness of the Supermalloy strip as part of an investigation to determine why magnetic quality degrades when the material is reduced to thin gauges. This phenomenon plagues all "soft" magnetic materials—that is, those with high permeabilities. It would be of great value to learn why a strip 0.014 in. thick, for example, has superior properties, while the same material of ultra-thin gauges does not.

### *Processing Methods*

In this study, an ingot was first hot-rolled and cold-rolled to a thickness of 0.001 in. with intermediate anneals. Then it was reduced to the final 0.0002 in. thickness on a high-precision mill.

The preliminary heat-treating and testing program results indicate that cobalt and manganese, in the concentrations mentioned, are desirable for securing the optimum magnetic properties of Supermalloy at normal thicknesses. In addition, it appears that high purity does not prevent magnetic quality from degrading at the ultra-thin gauges. The problem of maintaining the magnetic characteristics at these gauges is one of achieving a strain-free recrystallized alloy. With high-permeability materials, it has long been known that complete freedom from strain is essential to the development of the highest magnetic quality. This becomes difficult when the thickness and width dimensions become very small—that is, when so much of the material lies at or close to the surface.

Another project again illustrates the need for precise control of size, and also the need for uniform magnetic quality over great lengths of fine, flat wire. This wire, used for magnetic memories, is made of molybdenum Permalloy by flattening a round wire to a cross section 0.00035 in. thick and 0.00325 in. wide.

Producing this fine cross section by rolling on a standard wire-flattening mill soon becomes unsatisfactory because the rolls begin to wear detectably after only 60 min. of rolling at 100 ft. per minute. The significance of this problem is apparent from the fact that with the specified dimensions, one pound of Perm-

alloy produces about 60 miles of magnetic wire. This amount of wire has a potential of storing over 30 million bits of information.

Another method for preparing fine, flat wire is to draw it through a slit formed by a pair of diamond dies. Since molybdenum Permalloy has no abrasive characteristics that would wear the diamonds, the thickness of a 20,000 ft. length of flat wire does not vary. This project requires even greater accuracy than the Supermalloy for transformers; here the thickness is controlled to only a few millionths of an inch.

To reduce a one-pound bar only 8 in. long to 60 miles of extremely fine wire, it is evident that considerable processing is necessary. And, since such processing controls the metallic structure of the end product, current fundamental studies in metallurgical research are designed to establish a better correlation between structure and magnetic characteristics. These studies are vital to an understanding of materials at very small dimensions.

Another project currently being carried out in metallurgical research is the processing of a magnetic alloy to secure a specified thermal coefficient of the modulus of elasticity.

The problem is as follows: Some receivers for mobile radio and personal paging systems use metal tuning forks that respond to specific incoming frequencies. The signals are applied to a magnetic circuit associated with the forks, and these forks that are resonant to the applied frequencies are set in vibration. It is desired, of course, that the resonant frequency of a tuning fork should stay constant, even though the alloy of which it is fabricated expands or contracts, and the modulus or stiffness varies with temperature.

For a particular application by L. G. Bostwick and K. F. Bradford of the Switching Systems Development Dept., small reeds, measuring only 0.006 in. thick, 0.1 in. wide and less than 1 in. long, were fabricated into precise, miniature tuning-fork resonators. These reeds had to vibrate at a constant frequency over a wide temperature range. Also, they must have good fatigue properties, be relatively stainless, and be capable of being driven magnetically.

### *New Applications*

It was impractical to reduce the original Permendur to a fine wire, but with Supermendur, a fine, hard-drawn wire has been reduced from a dia. of 0.05 in. to 0.0009 in. without intermediate annealing. This fine wire has been used in delay-line structure, and the thin-gauge strip, hitherto unavailable, is being used in special transformer designs.

Three, four and more zeroes to the right of the decimal point have thus become vitally important. As metallurgical techniques becomes more and more exact, better communications components and devices inevitably follow. And of comparable significance is the fact that many of the techniques described in this article can be translated to tonnage production. In this respect, another illustration is the high-purity nickels prepared by K. M. Olsen. These nickels can be used in fabricating cathodes for high-performance vacuum tubes having a very long life, are to be produced in large quantities by the Western Electric Co. Works

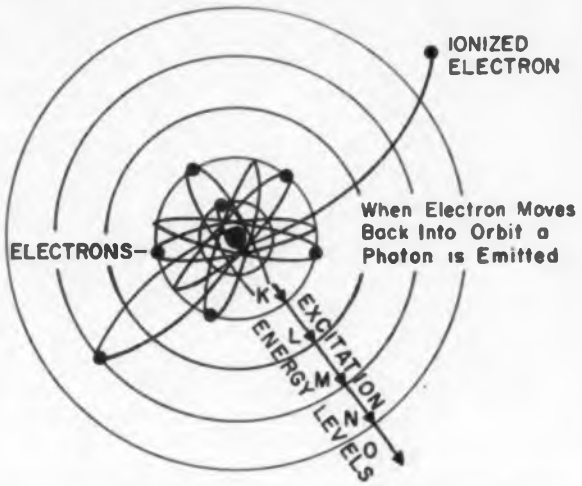



Fig. 6. Nucleus and electrons in energy level orbits. Excitation occurs when electrons move to higher energy levels indicated by KLMNO. Ionization occurs when the electron escapes these levels.

at Hawthorne, Illinois.

Since 1950, developments at Bell Laboratories have indeed shown the crucial value of "metallurgy in the millionths." Further, the trend is evident generally throughout the metallurgical industry. Semiconductors, high-temperature and corrosion-resistant alloys, atomic-reactor materials, and numerous electronic and magnetic alloys are now available—in quantities and with purities that were considered impossible only a few years ago. These improvements will undoubtedly be more rapidly introduced in the future.

### *Plastics in Electronics*

The role of the new plastic compounds is becoming more and more useful to the electronic manufacturer. As there is hardly no field in which the uses of electronics are not needed, and the environments of operation of the devices range from under the sea to the surface of the moon and beyond. In space the missiles need electronic reliability in conditions through severe shock, vibration and in extremes of temperature, the effect of moisture and also requires equal consideration. Research in these areas have shown the versatility of plastics and rubber compounds in many new solutions to these engineering problems.

### *Resin Laminates*

The various dielectric properties of materials have become very important. It is in this area that plastics have excelled. Generally plastics have low specific gravity and dielectric properties, and can satisfy many of the electronic problems now in existence, such as radomes, R.E. windows polarized gratings, horn covers and other radar applications.

As the accuracy of guidance systems became more precise the requirements for radomes becomes more rigid. Such properties as density, moisture absorp-

tion, temperature resistance and weather erosion were taken into consideration. The dielectric properties at elevated temperatures as well as resistance to moisture and humidity were examined.

The materials selected were evaluated and measured at 10. KMC (X band), a thermal frequency for radar operations.

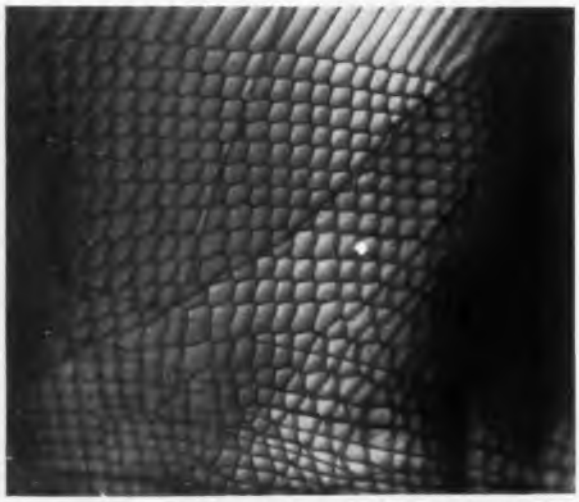
Laminates were constructed of epoxy, polyester, and silicones. Experimental panels were constructed using standard hand layup laminating techniques, vacuum bag, press and autoclave.

In this method of dielectric measuring, the sample material is machined to fit snugly inside of the wave guide to insure the wave propagation is through the material.

Actual measuring is accomplished by using a slotted line in conjunction with a tuned crystal probe.

These measurements and other known constants of the systems; i.e., propagation factor frequency, wave length, etc. yield the necessary date for obtaining the dielectric constants and the loss tangent of the tested materials.

Each sample was measured at room temperature. Then the sample was immersed in distilled water for twenty-four hours. At the end of this period, the samples were then measured in the wet condition.



Crystal structure of bismuth telluride makes it especially suitable for the study of dislocations found in thin foils.
*(Photo—Bell Laboratories)*

After the measurement in the wet state was completed the temperature was increased to 250° F. and the next measurement made. Finally, the temperature was increased to 500° F. and the final measurements made. At each temperature the sample was conditioned for one hour to allow all parts, sample holder, sample and wave guide to stabilize at the respective temperature.

These measurements indicate a definite change in dielectric constant and loss when subjected to increasing humidity and temperature. The amount of change is dependent on the resin type, percent content and techniques of fabrications. Decrease in dielectric constant and loss was noticed at the higher temperature in some materials. This could be attributed to a loss of moisture at these temperatures.

This diffusion apparatus is used to introduce controlled amounts of impurities into semiconductors such as silicon or germanium. Vapor pressure of these impurities is regulated by insertion into one of the furnace temperature zones. Diffusion depths and impurity concentrations are determined largely by the temperatures.

The use of reinforced plastics in the electronic field makes it important that continued research be continued along the line of precision and understanding of the basic dielectric properties of reinforced plastics. It is important to appreciate that the present and future requirements in most applications can be met by careful choice of materials and design.

It is necessary that a correlation of electrical and mechanical properties of materials be recognized when considering reinforced plastic components in regard to future requirements where electrical and high temperature conditions exist.

In recent years thermosetting polymeric systems have been used extensively as binders in electrical insulation and composite plastic structure with excellent success. However, such properties as post-cure gassing, thermal stability and high-temperature bond strength have always been stumbling blocks for the insulation engineer. Experience has shown that these properties can ultimately affect the dielectric endurance of an insulation when subjected to high voltage stresses. The above mentioned problems are generally controlled by the organic binders present in the insulation. Test methods have been developed whereby the behavior of the polymers under certain conditions can be predicted, thus increasing the effectiveness of the design engineer.

### *Insulators in Plastics*

Of particular importance for electrical insulation is the development of systems using thermosetting polymers such as epoxy, polyester, phenolic and silicon resins. For most insulation applications, such as potting, encapsulation, molding, high voltage insulation, etc., these polymers have been found to be superior to the thermoplastic types, principally because of their greater thermal stability and retention of physical properties at high temperatures.

The main properties desired in a polymer to be

used in the insulation of rotating electrical equipment are indicated below.

1. Good dielectric properties
2. Good thermal stability
3. Low gassing
4. Good mechanical strength
5. Ability to withstand long time application of of voltage stress.

Other properties of a more practical nature are low toxicity, good processability, compatibility with other materials, and low cost.

In high voltage applications, ionization of the gas in such pockets may well lead to electrical leakage, local heating, tracking, carbon deposits, and finally breakdown of the insulation system. Any boundary such as that between conductor and insulation, or between various layers in the insulation system itself, may suffer from this condition. One way to obtain better thermal stability is to select a polymer system with appropriate chemical properties. For example, the system should be chemically homogeneous with side reactions eliminated as much as possible.

Very often the design engineer is confused by the wide choice of existing polymeric systems. Undoubtedly, environmental tests will be the final criterion on the performance of a specific dielectric structure. Unfortunately, such tests are time consuming and sometimes exorbitant in cost.

### *Waveguide Materials*

In passing from the medium and high frequencies to the ultra and super high region of the microwave spectrum, materials with internally and uniformly distributed resistance, capacitance and inductance fulfill an important component function. Under the condition of most microwave applications the problems of leads and encapsulation in the conventional sense do not arise since the materials themselves take on the functions of a component. Fig. 5 shows a range of waveguide termination units for use at X-band. They consist of finely divided dielectric and magnetic powders dispersed in a layer of critical thickness mounted on a reflecting base. Through the distributed equivalent R, C and L of the dispersed powders the material exhibits a high absorption and refractive index, and the standing wave set up across the two faces is completely absorbed at the design frequency. This is one example of the use of such materials in microwave systems.

### *Ceramics*

In the field of electronics the uses of ceramics are finding increased applications as in the case of silicon carbide which is used for ceramic semiconductors. Various mixtures of metallic oxides such as manganese, cobalt, nickel, iron and copper are used in sintered form and vitrified for semiconductor applications. Mainly these devices are used as semiconductors in thermistors for electro-mechanical instrumentation, and electronic circuitry.

Ceramics provide a variety of material combinations. In general they are used in electronics where low voltage coefficients and normal dissipation capacities, and low temperature coefficients. Other compounds provide low (positive) to high (negative) temperature coefficients, nearly zero to very high voltage coefficients, and normal to exceptional dissipation capabilities.

These various types of thermistors may also be coated with organic material for temperatures up to 300 F. Glass coated thermistors may be mounted in vacuum, or in gas filled envelopes to operate up to 930 F.

A range of materials have been developed with large temperature coefficients which in the main consist of barium titanate or barium strontium titanate containing small amounts of lanthanum. Other materials have been used as additives, such as bismuth, thorium and rare earths. These material compounds have been found to have a positive temperature coefficient over a range of about —50 to 230 F, with the coefficient as high as 5% per ° F.

In the very high temperature range (1000 to 2000 F) thermistors have been made of different compositions in the potassium alumino-silicate system. Certain alkali alumino-silicates maintain their resistivity-temperature calibration as high as 1800 F. and are not affected by oxidizing or reducing atmospheres.

### *Intermetallic Compounds*

Many intermetallic compounds hold great promise for semiconductors. Silicon and germanium metals are listed in the table Semiconductors and Materials, to show the comparisons.

Some of the materials are rare, but could be made available if needed in quantities. Bismuth telluride, indium antimonide and lead telluride are now commercially available. Further uses of these compounds may be found in eventual applications such as: rectifiers and transistors for high temperatures, galvano-magnetic devices for computer elements, electronic compasses, amplifiers, microphones, optical devices in infrared systems, solar batteries, thermoelectric device for power, or refrigeration.

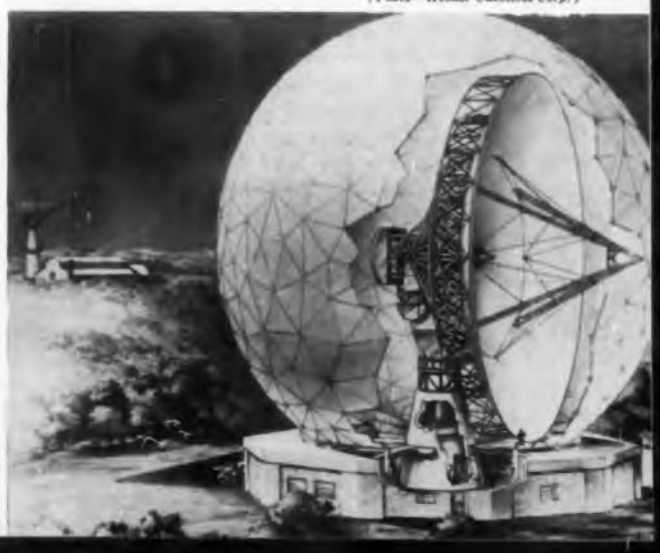
### *Insulation Materials*

Tougher operating conditions are demanding many new and improved materials for insulation applications.

Some problems in electronics are being solved

**Fire-retardant, glass-reinforced Hetron polyester, 1/32-in. thick, protects the Air Force's unique radio-research facility against weather at Tyngsboro, Mass. Radome is 150 ft. in diameter.**

*(Photo—Hooker Chemical Corp.)*



through the use of lightweight urethane foams for encapsulation techniques.

Encapsulation systems and impregnation for airborne instruments are currently finding new significance in formulation of epoxy novolac as an ideal material for resistance to severe thermal cycling, aging, salt spray, fungus, and vibration. The formulation consists of epoxy novolac with a eutectic mixture of nadic anhydride and hexahydropthalic anhydride. It is especially notable for its high temperature properties, and light weight.

Inorganic materials such as ceramic, mica, asbestos and certain glasses have assisted in overcoming problems in high temperature insulation.

An example of one application is given in a transformer insulation, which can operate at temperatures as high as 1100 F. The transformer uses a layer of phlogopite mica paper bonded with 15% silicone resin. The smaller wires are made of silver with a double glass serving; silver plated, oxygen-free, high conductivity copper wire is used for the larger sizes. The core and coil are impregnated with a colloidal silica to bond the two components together. The assembly was then supported with a ceramic potting compound. The entire assembly is sealed, after heating to 1180 F under a vacuum, with nitrogen introduced under pressure.

Impregnated wood veneers, or compregs are valuable in applications of switch gear and their electrical properties are often neglected, as the materials provide excellent aging properties. The dielectric components function reliably after long periods of inactivity, and prevent arc-over.

### *Reinforced Ceramics*

The effect of high temperatures on radome materials presented a problem to produce materials able to resist change at great heat and have good dielectrical strength with great physical strength.

The electrical specifications prevented metal reinforcements. The application of fused silica to a reinforcing fiber and phosphate binding technique was developed.

As a point of interest, the work in these projects produced flexural strengths of 10,000 to 15,000 psi, which considering the limitation of the specification was very high. However, the strength declined after prolonged aging processes to 8600 psi, but at 1300 F no further decline in strength was evident.

The addition of asbestos floats raised the strength to 20,000 psi, but after raising the temperature to 930 F the laminate specimen had a lower strength than the others. When the asbestos content was raised to 6% the strength was increased up to 24,000 psi at 930 F.



**Silicon impurities are determined by electron spin resonance**
*(Photo—Bell Laboratories)*

The high frequency properties were tested under high temperatures, and at 9150 mc at temperatures between 77 to 1100 F the dielectric and frequency properties were satisfactory. Especially in view of the poor electrical properties of aluminum phosphate itself.

It is important that the stress-strain properties be improved in these materials through the reinforcement and binders. The tensile strength of glass for example is in the region of 400,000 psi, but in processing, the damage to the fibers reduces the strength to half this figure. In addition, elongation has to be considered, and the effect of chemical actions and lubricity and heat, all decide the ultimate end product.

To appreciate the future potentials of these materials, some of the present fibers would have to have a modulus of 100 million psi to realize the ultimate strength of the existing ceramic binders. This is not foreseeable at any time within the next few years.

### *Acknowledgements*

The author is grateful for the assistance and technical information provided by the Research Laboratories of the following companies:
Corning Glass Works, New York
American Telephone & Telegraph Co., New York
Foote Mineral Co., Philadelphia
General Electric Co., New York
The Franklin Institute, Philadelphia
The National Bureau of Standards, Washington
E. I. Du Pont de Nemours & Co., Delaware.
Society of Plastic Engineers Inc., Stamford
Battelle Memorial Institute, Columbus
Thompson Ramo Wooldridge Inc., Cleveland
Institute of Radio Engineers, New York
Armour Research Foundation, Illinois
IBM Research Center, New York
Linde Co., Div. Union Carbide Corp., New York
Fairchild Semiconductor Corp., California
Remington Rand, Blue Bell, Pa.
Rogers Corp., Connecticut
Materials in Design Engineering, New York

And for the assistance of Dr. F. Donahoe, Franklin Institute Philadelphia, Pa., who reviewed the original text.


# ALLEN-BRADLEY TYPE TR RESISTORS

## are STANDARD for today's miniaturized hearing aids

Because of the engineering ingenuity of the manufacturers, hearing aids have become so tiny they are hardly noticeable—since the principal objection to wearing a hearing aid has been overcome, ever increasing thousands are enjoying this remarkable contribution to the joy of hearing.

Allen-Bradley is proud to play a part in this important development. The extremely tiny Type TR fixed resistor (actually smaller than a grain of rice) is used by virtually every hearing aid manufacturer to help achieve today's amazing miniaturization—without sacrificing reliability!

Tiny as they are, these miniature resistors—made by Allen-Bradley's exclusive hot molding process—*have never experienced catastrophic failure in service*. They are remarkably "uniform" to their resistance rating. Therefore, you are only fair to yourself—and your customers—when you insist on the reliability of the A-B Type TR resistors.

For complete details, please send for Technical Bulletin 5001, and Publication 6024 which also includes information on other A-B space-saving electronic components.

**SOME OF THE MANUFACTURERS OF HEARING AIDS WHO RELY ON A-B TYPE TR RESISTORS**

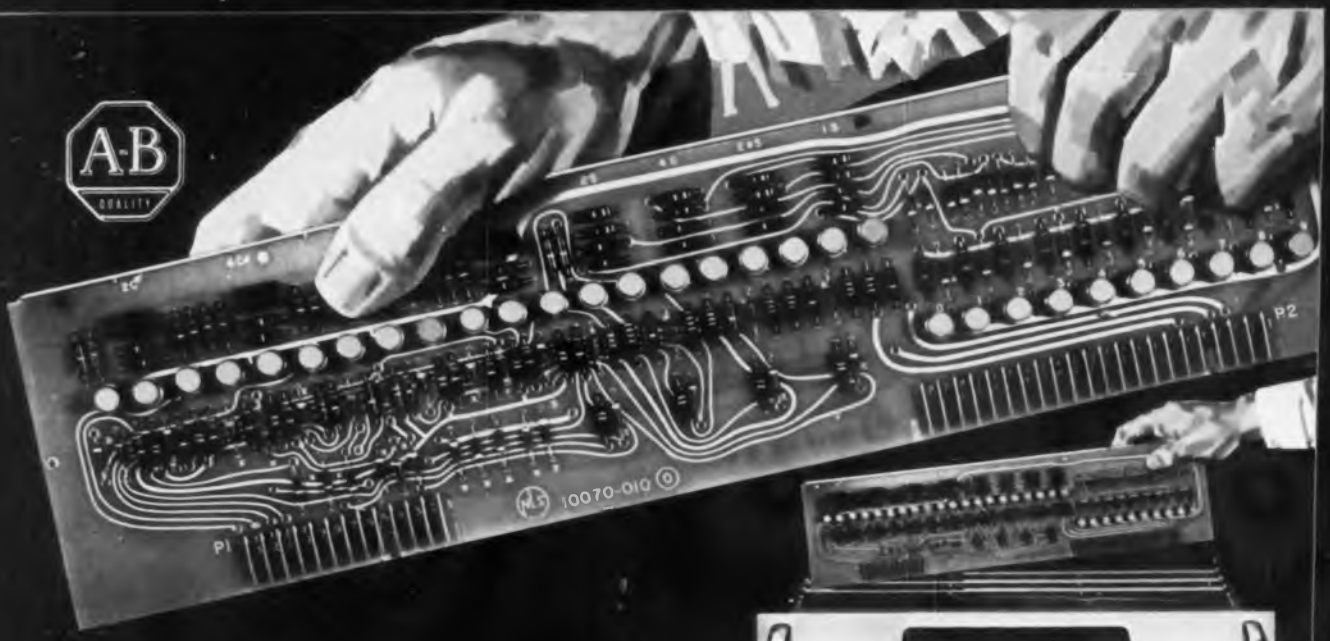
American Sound Products, Inc.
Audivox, Inc.
Beltone Hearing Aid Company
Busse Electronics Company
Dahlberg Company
Dictograph Products, Inc.
Electro Acoustic Research Labs., Ltd.
Gem Ear Phone Co., Inc.
Halhen Widex, Inc.
Johnston Hearing Aid & Electronics, Inc.
Maico Electronics, Inc.
The Microtone Company
E. A. Myers & Sons, Inc.
Otarion Listener Corp.
Qualitone Company, Inc.
Sonotone Corp.
Telex, Inc.
Unex Laboratories
Vari Electronics, Inc.

9-61-E

# ALLEN-BRADLEY

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

QUALITY
ELECTRONIC COMPONENTS




## Non-Linear Systems, Inc. designs first digital voltmeter to satisfy critical standards for missile work

Digital voltmeters – originated by NLS – permit rapid and accurate voltage measurements. New Series 20 unit – with one plug-in decade board removed – shows the use of Allen-Bradley fixed resistors.

# Resistor Failures UNHEARD OF

...naturally, NLS uses ALLEN-BRADLEY hot molded resistors

To satisfy the high standards of consistent accuracy and reliability demanded for missile and weapons checkout, Non-Linear Systems, Inc., developed this digital voltmeter. It uses scores of Allen-Bradley fixed resistors. (For example, the latest Series 20 unit, shown above, contains about 1,000 in each instrument.) "In the selection of A-B resistors," says NLS, "quality and availability have never been a problem."

A-B resistors have such consistently uniform electrical characteristics that their performance can be accurately predicted over long periods of time under various operating conditions . . . with *complete freedom* from catastrophic failure while in service! The hot molding process used exclusively by A-B is the reason for this uniformity and reliability.

To obtain this same measure of superior performance for your equipment, always insist on Allen-Bradley quality fixed resistors available in various types. For full details, send today for your copy of Technical Bulletin 5000 or Publication 6024. Write to: Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis. In Canada: Allen-Bradley Canada Ltd., Galt, Ontario.

## ALLEN-BRADLEY Hot Molded Resistors

ACTUAL SIZE

Hot molded composition resistors are available in all standard EIA and MIL-R-11 resistance values and tolerances.

**Pending MIL Spec Assignment*


# ALLEN-BRADLEY

QUALITY
ELECTRONIC COMPONENTS

# Change of Address

*Mail entire page to:*

**ELECTRONIC INDUSTRIES**
**Att.: Circulation Dept.**
**56th & Chestnut Sts.**
**Philadelphia 39, Pa.**

I wish to continue receiving "ELECTRONIC INDUSTRIES." Change my address as indicated below:

Paste Wrapper imprint here, or . . .

OLD

. . . Write in complete old address

*NEW*

Company .....

DIVISION
DEPARTMENT
MAIL STOP # .....

Street .....

City ..... Zone ..... State .....

***IMPORTANT***

FOR OUR STATISTICAL RECORDS PLEASE CHECK **THE ONE** APPROPRIATE CATEGORY. Failure to do so will delay your address change.

- ☐ Mfr. of non-military electronic receiving and transmitting equipment.
- ☐ Mfr. of non-military electronic instruments, measuring, control and test equipment.
- ☐ Mfr. of non-military electronic computers, data processing, analysers, business machine.
- ☐ Mfr. of Guided Missiles and Accessories; Aircraft and Accessories, All Type of Military Products and Equipment.
- ☐ Mfr. of electronic components, parts, tubes and like products.
- ☐ Mfg. Co. (non electronic) using any of the above equip. in mfr., research or development work.
- ☐ Broadcasting or telecasting station.
- ☐ Commercial communication user (Tel & Tel, Police, Airports, Recording Studio, Etc.).
- ☐ Independent research, test, design laboratories and independent consultants — not part of a mfg. Co.
- ☐ Gov't Bureaus, Gov't laboratories, Gov't research center, military installation.
- ☐ Wholesaler, mfg. representative, service firm.
- ☐ University (educational) Public Library.
- ☐ Other (Please explain) .....

Your Signature, Please ..... Title ..... Date .....

←——Circle 106 on Inquiry Card

# New Products

## FREQUENCY METER

*Its accuracy is within FCC limits for freq. interference measurements.*

This micrometer-tuned wavemeter in a new field carry case, covers various freq. ranges between 500 and 10,000MC. Designed as a passive unit, the meter is suited to the measurement of freqs. used in microwave relay links. Invar is used on all freq.-sensitive elements to maintain accuracy of ±0.01% over a temp. range of −20 to 70°C. Resetability is ±0.005%. Frequency Engineering Laboratories, P. O. Box 504, Asbury Park, N. J.

Circle 210 on Inquiry Card

## DUAL-TRACE OSCILLOSCOPE

*This complete pulse-sampling system has a rise time of 0.35 nsec.*

Type 661 meets most general-purpose-measurement demands in repetitive-signal applications. Characteristics include capabilities for triggering externally, or internally on either A or B trace: for observing equivalent sweep times from psec. to a msec.; for displaying repetitive signals from fractions of mv to volts; for meauring risetime from hundreds of psec. to a msec. Will show Lissajous patterns. Tektronix, Inc., P. O. Box 500, Beaverton, Ore.

Circle 211 on Inquiry Card

SPERRY ELECTRONIC TUBE DIVISION

microwave memo

# Sperry adds high-power pulsed TWT's to list of tubes available in 30 days

In a move to simplify design problems in present and future radar systems, Sperry Electronic Tube Division of Sperry Rand Corporation has added two high-power pulsed traveling wave tubes to the list of advanced microwave tubes available in 30 days.

The two tubes covered by the announcement—the STL-114 and the STC-152—operate in L and C bands, respectively. They are typical of a line of pulsed TWT's ranging from P through V bands which Sperry offers on a firm delivery date basis.

### EASY RADAR APPLICATION

Sperry's pulsed TWT's are admirably suited to the demands of application in phased array radars, height finders, search, ECM, and other radar applications. Widely varied in-system experience has proved that their reliability, long life, high power, high gain, and extreme broadband operation make them ideal for radar use.

Design features of this tube family minimize the necessity for system adjustments in the field. Among these features are broadband response, constant voltage operation, and short circuit stability.

### VERIFIED RELIABILITY

These pulsed TWT's, produced at Sperry's Great Neck, N. Y., facility, have compiled an impressive record of in-system experience. Such experience has proved that their resistance to shock and vibration damage, their inherent indifference to ambient conditions, and their mounting flexibility make them ideal for ground or airborne application.

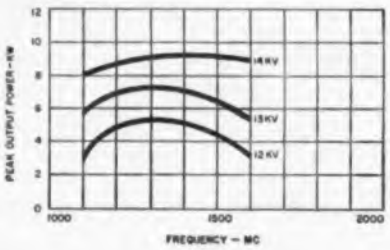
Place your order with your Cain & Company representative. His phone number appears in the adjacent column. Tubes are available within 30 days after receipt of order.

**FREE TECHNICAL INFORMATION on the Sperry line of high-power pulsed traveling wave tubes may be obtained by writing to Sec. 103, Sperry Electronic Tube Division, Gainesville, Florida.**

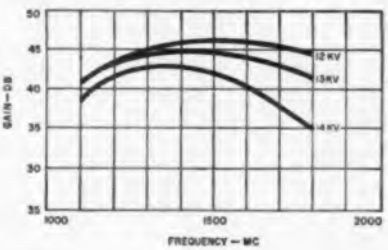
### V BAND CAPABILITY

Among Sperry's other interesting activities in pulsed TWT's is the extension of capability into the V Band —26.5 to 40.0 kMc. Although these efforts are largely classified, inquiries are invited from those who have the necessary clearance and need to know.

**FACTORY ALIGNMENT of a Sperry TWT within its focusing solenoid greatly simplifies field maintenance. Once this operation has been performed by a skilled Sperry technician, the assembly is self-aligning.**




**Typical saturated power output vs. frequency for a pulsed Sperry TWT.**




**Typical small signal gain vs. frequency for a pulsed Sperry TWT.**

SPERRY ELECTRONIC TUBE DIVISION

GAINESVILLE, FLA. / GREAT NECK, N. Y.

SPERRY RAND CORPORATION

# 1 Kw
# 14-18 Kmc

**Z-5183 (CW)**
**(without solenoid)**

| | |
|---|---|
| Saturation Gain | 30 decibels, min |
| Power Output, CW | 10 w, nominal |
| Length | 9 inches |
| Weight (including solenoid) | 34 pounds |

**Z-5182 (CW)**
**(PPM)**

| | |
|---|---|
| Saturation Gain | 30 decibels, min |
| Power Output, CW | 150 mw, min |
| Length | 11.2 inches |
| Weight | 3.0 pounds |

**Z-5184 (Pulsed)**
**(without solenoid)**

| | |
|---|---|
| Saturation Gain | 25 decibels, min |
| Power Output, peak | 1 kw, nominal |
| Duty Cycle | 0.01, nominal |
| Length | 11 inches |
| Weight (including solenoid) | 20 pounds |

## General Electric Announces Three $K_u$ Band TWT's With Power Up to 1 Kw

A significant breakthrough in microwave technology now permits General Electric to offer highest available $K_u$ Band power output.

Developed under an Air Force contract, the three new tubes can be operated singly or in cascade. The highest rated TWT, Z-5184, delivers 1 kw peak. The Z-5183 delivers 10 w CW, and the Z-5182, 150 mw CW.

With their broad bandwidth, high gain, and rugged metal-ceramic construction, General Electric TWT's offer optimum performance in critical applications, such as radar, CW amplification, ECM, microwave relay systems and radiometry. They are also particularly suitable for aircraft and space vehicle systems.

Sample tubes are available for customer evaluation. To obtain more information on these General Electric traveling-wave tubes, contact your nearest Power Tube Sales Office (telephone numbers listed below). Or write to Power Tube Department, G-E Company, Schenectady, N. Y., for bulletin PT-58.

265-12-9545-8481-44

POWER TUBE DEPARTMENT

**GENERAL ELECTRIC**

*TELEPHONE TODAY*—Syracuse, OL 2-5102 . . . New York City, WI 7-4065 . . . Clifton, N. J., GR 3-6387 . . . Washington, D. C. EX 3-3600 . . . Chicago, SP 7-1600 . . . Dayton, BA 3-7151 . . . Orlando, Fla., GA 4-6280 . . . Los Angeles, GR 9-7765

# New Products

## TAPE CABINET

*For storage of magnetic tape at point of use.*

Video tapes, telemetering data, audio as well as programming data can be protected against extraneous magnetic fields, while stored at or near the point of use. Built in removable sections, are similar to a sectional bookcase and the doors slide back and forth easily on ball bearings. This sectional cabinet is magnetically shielded by Netic magnetic shielding alloy which is non-shock sensitive and non-retentive. Magnetic Shield Div., Perfection Mica Corp., 1322 N. Elston Ave., Chicago 22, Ill.

Circle 212 on Inquiry Card

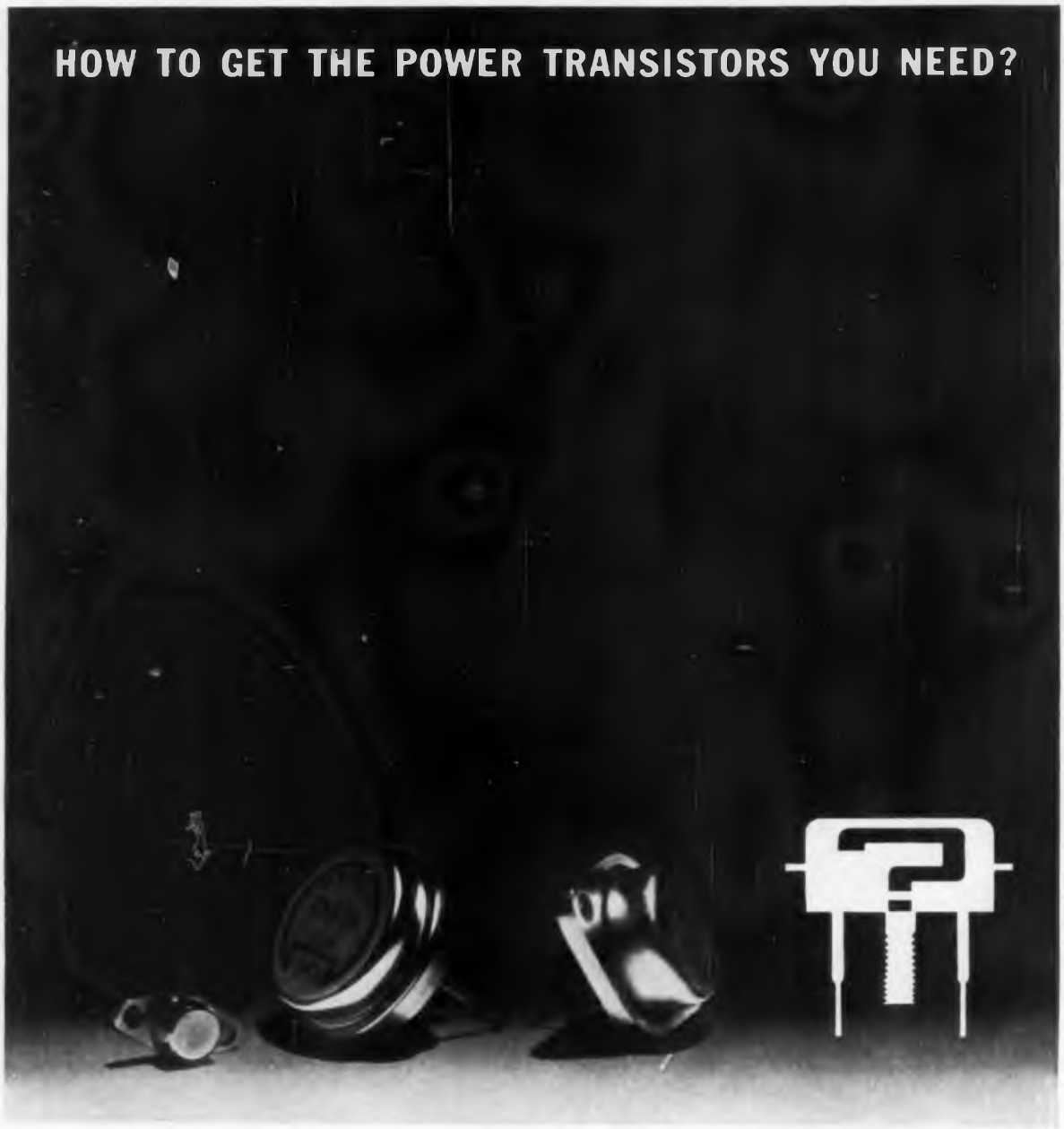
## ITERATIVE COMPUTER

*Analog computer features modular packaging and 0.01% components.*

Donner's 3200 computer series incorporates a 0.05% solid state multiplier and stored program function generators. Computing components are matched to 0.01% within temp. controlled ovens. Nominal size is 50 amplifiers; 2 or more computers may be slaved together. Inverter bandwidths of 1 MC assure accuracy during fast iterative computations. Pushbuttons select compute, hold, reset, automatic recycle, slave, audible overload indication, and automatic hold modes of operation. Donner Scientific Div., Systron-Donner Corp., Concord, Calif.

Circle 213 on Inquiry Card

# HOW TO GET THE POWER TRANSISTORS YOU NEED?



**JUST ASK DELCO.** For even though our catalog lists only a handful of germanium power transistors, there is only a handful out of all those ever catalogued that we don't make. And those only because nobody ever asked for them.

We've made, by the millions, both large and small power transistors. Both diamond and round base. Both industrial and military types. And each in a wide variety of parameters that have proved themselves reliable in nearly every conceivable application.

You get Delco transistors fast. You get Delco transistors in any quantity. And for all their high reliability, you get them reasonably priced. All you have to do is contact our nearest sales office—and ask for them.

Union, New Jersey
324 Chestnut Street
MUrdock 7-3770

Santa Monica, California
726 Santa Monica Blvd.
UPton 0-8807

Chicago, Illinois
5750 West 51st Street
POrtsmouth 7-3500

Detroit, Michigan
57 Harper Avenue
TRinity 3-6560

Syracuse, New York
1054 James Street
GRanite 2-2668

DELCO RADIO
DEPENDABILITY
RELIABILITY

Division of
General Motors
Kokomo, Indiana

# New Products

## DISCRIMINATOR

*Designed to drive high-speed electronic scalers.*

Model 2301 Pulse Height Discriminator provides an output pulse only when the input signal is within a preselected amplitude range. Will resolve paired-pulses spaced as close as 0.5 μsec. Model 2301 is especially suited for nuclear radiation or X-ray spectrum analysis. Precision 10-turn potentiometers permit independent selection of upper and lower levels, or base line with predetermined window width. It measures 5¼ x 19 x 16 in. Beckman Instruments, Inc., Berkeley Div., 2200 Wright Ave., Richmond, Calif.

Circle 214 on Inquiry Card

## SILICON RECTIFIERS

*Six new lines of kilovolt silicon cartridge rectifiers.*

They are hermetically sealed, with all-welded construction. Three axial-lead, cylinder-type lines consist of 14 LT models, LT1121 through LT1138; 5 JEDEC models, 1N1730 through 1N1734, and 12 JEDEC models, 1N2374 through 1N2385, providing working voltages to 10 kv. A fuse clip line, with ferrule terminals, includes 18 JEDEC types, 1N1133 through 1N1149 and provides working voltages to 16 kv. An axial-lead rectangular line includes 14 LT types, LT1221 through LT1238, providing working voltages to 10 kv. A lateral-lead rectangular line includes 14 JEDEC types, LT1321 through LT-1338, also providing working voltages to 10 kv. Micromodular Components Div., Ling-Temco-Vought, Inc., P. O. Box S-1, Anaheim, Calif.

Circle 215 on Inquiry Card

## New Products

### VOLTAGE COMPARATOR

*Detects dc voltage levels in the range of −6 to +6 vdc.*

Voltage Comparator T-172 is a transistor circuit module containing a differential amplifier that drives a pre-biased squaring amplifier to provide a well defined switching point. Sensitivity is 0.1 v. over the temp. range of −54°C to +71°C. Outputs are compatible with the manufacturer's T-Series family of digital circuit modules. Packaged in the standard T-Series container, measuring ⅞ x 2 3/16 in. seated height. Engineered Electronics Co., 1441 E. Chestnut Ave., Santa Ana, Calif.

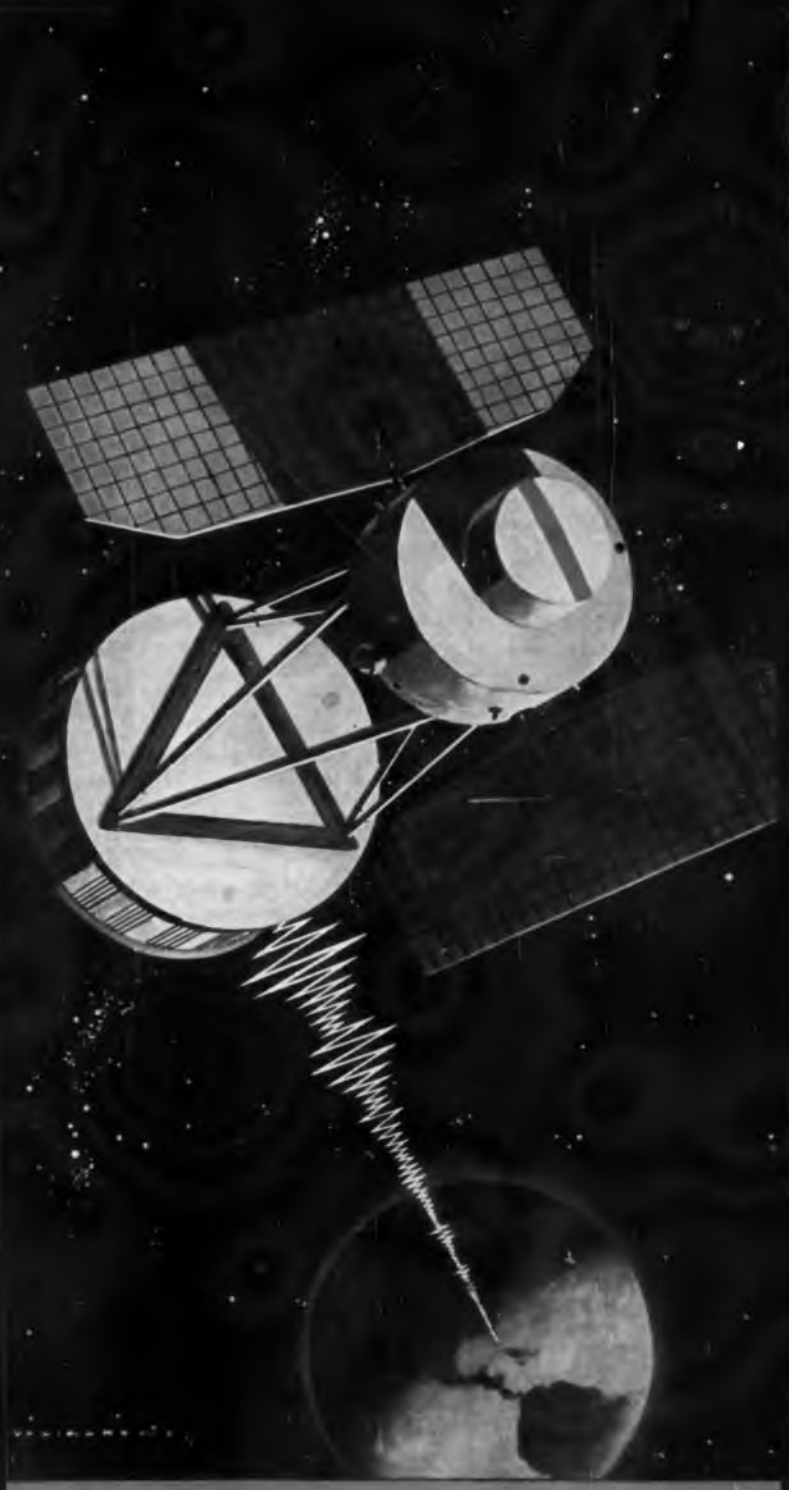
Circle 216 on Inquiry Card

### POTENTIOMETER

*Raysistor, CK1114 is for either switch, relay or potentiometer use.*

The Raysistor is a pedestal-free analog switch. It uses a tiny incandescent bulb as the control element and a miniature photosensitive resistor as the signal element. The Raysistor control circuit can be driven by 25 mw at 1 v. When illuminated by this power, the photosensitive cell changes its resistance value from 3 x $10^{\omega}$ to 460$\omega$. It withstands up to 60 vdc across its terminals, and signal circuit will dissipate up to 50 mw. The unit is 0.370 in dia., 0.260 in. high and weighs 0.4 oz., similar in size to a TO-5 case. Raytheon Co., Industrial Components Div., 55 Chapel St., Newton, Mass.

Circle 217 on Inquiry Card



## *Avco and...*
# satellite signal selection

**Space vehicles** are constantly exposed to many signals as they orbit the earth. Electronic interference, false messages... these are but two of the problems they contend with.

**To receive correct commands,** a new coder-decoder has been developed by Avco's Electronics and Ordnance Division working with NASA. Built around a single-conversion concept, the Avco unit ignores stray signals, shuns radio noise and interference. Today it is operating in Explorer XI, now orbiting the earth.

**Miniaturized** to save weight and space, this uniquely selective radio device will pull in only proper information, feed it to the decoder, and actuate the correct on-off controls and other satellite equipment as ordered.

**Communications capabilities** are among the many contributions of the Electronics and Ordnance Division's experienced engineering talent and skill. For more information on this new satellite receiver-decoder, or answers to your own communications problems, write: Director of Marketing, Communications Operation, Electronics and Ordnance Division, Avco Corporation, Cincinnati 15, Ohio.


**Avco** / ELECTRONICS AND ORDNANCE DIVISION

Circle 118 on Inquiry Card

# New Products

## RESISTOR KIT

*Kit has 7 microminiature solid cermet (CERADOT) fixed resistors.*

Each has a different resistance value within the range of 250Ω to 125KΩ. Each resistor is 0.050 in. dia. x 0.030 in. thick and is without leads. Other sizes, shapes and specs. with or without ribbon leads are available. Cermet has inherent high stability and reliability at extreme temps. and severe environments. They are designed for insertion into "Swiss cheese" type printed circuit boards for extremely microminiaturized applications. CTS Corp., Elkhart, Ind.

Circle 219 on Inquiry Card

## VOLTAGE COMPARATOR

*Transistorized unit designed for missile and automatic control use.*


Model VC670 continuously compares a random signal with an external reference voltage and provides a fail-safe alarm (contact opening) when the signal value exceeds the external reference limit. It measures 3.0 x 4.0 x 1.5 in. and weighs 10 oz. Specs: Input impedance, 2 megs between signal and reference leads; Sensitivity, 5 mv.; Signal overvoltage protection, ±80 v.; Power required, 115 v. at 400 cps (or to customer requirements), 2 w. Operating range +30°F to 130°F. Verco, Inc., 1430-130th N.E., Bellevue, Wash.

Circle 220 on Inquiry Card

# NEW PC CONNECTOR for critical computer applications

Now—*from Continental*—a printed circuit connector that combines all the advanced design features for rugged service in missile, ground support and other critical applications. Expressly designed for high speed automatic wire-wrap connection techniques which combine better reliability with maximum wiring density in minimum space. Type 600-83-10 meets all applicable specifications of Bushipa MIL-C-21097.

3/4 ACTUAL SIZE

**Designed specifically for automatic wire-wrap connections. Solid square, sharp-edged brass terminations, gold plate over silver plate. Three #20 AWG wire-wrap connections can be made on each terminal.**

**64 contacts, bifurcated beryllium copper. Patented "Bellowform" construction accepts .054" to .075" printed circuit boards. Up to 192 connections in less than 7½" length.**

**Special molding geometry assures superior ruggedness under severe shock and vibration. Compound is glass filled Diallyl Phthalate per MIL-M-19833, Type GDI-30.**

**Polarizing slots in molding permit any required polarization by customer while retaining use of all 64 contacts.**

## DESIGNERS' DATA FILE

If you're designing around printed circuits you'll want to have Continental's Con-Dex File PC, compiled to help you select and specify the PC connectors best suited to your needs. For your copy, please write to: **Electronic Sales Division, DeJur-Amsco Corporation, Northern Boulevard at 45th St., Long Island City 1, New York (Exclusive Sales Agent) RAvenswood 1-8000.**



MICRO-MINIATURE • SUB-MINIATURE • MINIATURE • PRINTED CIRCUIT • RIGHT ANGLE PIN & SOCKET • CENTER SCREWLOCK

# CONTINENTAL CONNECTORS

CONTINENTAL CONNECTOR CORPORATION • WOODSIDE 77, NEW YORK

# SELECTED BY RCA FOR A HIGH RELIABILITY *PROJECT

## Here is MEASURED RELIABILITY!

**Ten thousand El-Menco high reliability dipped mica capacitors were put on life test at 85°C with 225% of the rated DC voltage applied in accordance with an RCA high reliability specification.**

*After 22,000,000 actual test unit-hours no** failures of any type occurred*

The accumulated 22 x $10^6$ test unit-hours without any failures can be used to calculate many different failure rates depending upon the confidence level desired. However, we shall explore the meaning of the results at a 90% confidence level.

Assuming no acceleration factor for either temperature or voltage, we have verified a failure rate of approximately .01% per 1000 hours. (Actually, there is a temperature effect and it has been found that, with the DC voltage stress remaining constant, the life decreases approximately 50% for every 10°C rise in temperature. There is also a voltage effect such that, with the temperature stress remaining constant, the life is inversely proportional to the 8th power of the applied DC voltage.)

Assuming no temperature acceleration factor and assuming the voltage acceleration exponent is such as to yield an acceleration factor as low as 100, we have nevertheless verified a failure rate of approximately .0001% per 1000 hours.

Assuming no temperature acceleration factor and assuming the voltage acceleration factor is on the order of 250 (test results are available to confirm this) we have accumulated sufficient unit-hours to verify a failure rate of less than .00005% per 1000 hours!

Note that all the above failure rates are calculated at a 90% confidence level!

**The El-Menco high reliability dipped mica capacitors are being supplied to the Radio Corporation of America for a high reliability military ground electronics project.*

**A failure was defined as follows:

1. A short or open circuited capacitor occurring during life test.
2. A part whose capacitance changed more than ±2% and whose capacitance did not fall within the original tolerance of ±5%.
3. A part whose final dissipation factor exceeded .002 .
4. A part whose final insulation resistance measured less than 100,000 megohms.

*Write for a copy of our "Reliability Study of Silvered Mica Capacitors".*

El-Menco Capacitors

## THE ELECTRO MOTIVE MFG. CO., INC.

Manufacturers of El-Menco Capacitors

WILLIMANTIC CONNECTICUT

■ molded mica ■ mica trimmer ■ dipped mica ■ silvered mica films
■ tubular paper ■ mylar-paper dipped ■ ceramic feed thrus ■ ceramic discs

Arco Electronics, Inc., Community Drive, Great Neck, L.I., New York
Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada
WEST COAST MANUFACTURERS CONTACT:
COLLINS ELECTRONIC SALES, INC., 535 MIDDLEFIELD ROAD, PALO ALTO, CALIFORNIA

# New Products

## DELAY LINES

*Hermetically sealed and designed for use on printed circuit cards.*

Case height of the lumped constant units is 0.40 in. max. Width: 1.40 in.; length may be varied as required. Time delay to rise time ratios of 5:1 require a delay line length of 1.6 in., for example. Ratios of 25:1 may be obtained with a length of 5.6 in. PCDL delay lines have a 500 vdc rating, low temp. coefficient, a max. attenuation of 0.7 db/$\mu$sec for rise times less than 0.15 $\mu$sec., and 0.35 db/$\mu$sec for rise times greater than 0.15 $\mu$sec. Tolerances can be maintained from −55°C to 125°C. PCA Electronics, Inc., 16799 Schoenborn St., Sepulveda, Calif.

Circle 221 on Inquiry Card

## DC POWER SUPPLY

*Six models cover 100 and 1000 vdc at currents of 100 ma and 1 a.*

Units have a repeatable accuracy of 0.01% and an absolute accuracy of 0.05%, as referenced to the international volt, as corrected. The Digital Set feature allows the operator to dial in the output voltage or current without the necessity of calibrating or balancing null meters. It is a precise secondary standard of voltage or current. Other special features allow the operator to select the max. output voltage to be attained for any current output setting. No potentiometers are used in setting output. Davenport Mfg. Div., Duncan Electric Co., Inc., Dept. ES-2, 2530 N. Elston Ave., Chicago 47, Ill.

Circle 222 on Inquiry Card

## New Products

### H PLANE FOLDED HYBRID T

*Combines high electrical performance with lightweight but rugged design.*

Model 15TH16 (RG98/U) standard H plane folded Hybrid T measures 1.000 in. length, has a 0.040 in. common wall and covers the freq. range from 67.0 - 73.0GC. Other electrical specs include: 0.25db maximum unbalance, 35db minimum isolation and maximum VSWR of 1.3. Microwave Development Laboratories, Inc., 15 Strathmore Rd., Natick Industrial Centre, Natick, Mass.

Circle 208 on Inquiry Card

### SEMICONDUCTOR NETWORKS

*Units ¼ x ⅛ x 1/32 include flip-flop, NOR, NAND and OR gates.*

The devices will handle 90% of the circuit functions of digital equipments, particularly for military computers, programmers, and other information processing application functions. They operate over a temp. range of −55 to +125°C (−67 to +257°F). Line includes SN510 and SN 511 flip-flop/counter circuits, types SN 512 and SN 513 NOR/NAND gates, types SN 514 two independent NOR/NAND gates in a single package and type SN 515 exclusive OR gate network. The SN 510 flip-flop and SN 512-514 NOR/NAND gates have power drain of 2mw, power drain of the emitter follower units, SN 511 and SN 513, is about 8mw for $V_{cc}$ = 3 v. Texas Instruments Incorporated, P.O. Box 5474, Dallas 22, Tex.

Circle 209 on Inquiry Card

# Tech Data
## for Engineers

### Harmonic Generators

A 12-page booklet, "Varactor Harmonic Generators as Power Sources at Microwave Frequencies," is available from Waveguide Systems Div., Microwave Associates, Inc., Burlington, Mass. The booklet discusses in detail both circuits and devices which use varactor diodes for freq. multiplication. It includes specific examples.

Circle 286 on Inquiry Card

### Temperature Sensors

Tech data on a complete family of platinum resistance temp. sensors is available from Trans-Sonics, Inc., Burlington, Mass. Offered in weld-on, cement-on, open, and closed probe configurations, all units are interchangeable to within ±1%. Special Product Note 5600.

Circle 287 on Inquiry Card

### Ratio Reference

Ratio accuracy of 1 part/10 million over a wide ratio range is made possible with the Double Decade Resistance Set DDRS-105 available from Julie Research Laboratories, Inc., 603 W. 130th St., New York 27, N. Y. Two decades of identical 10K JRL style NB Primary Standard resistors housed together in an oil-filled hermetically sealed metal case comprise the set.

Circle 288 on Inquiry Card

### Card Holder

EPSCO Components, 275 Massachusetts Ave., Cambridge 39, Bass., has tech data available detailing the features and specs. of the TDC "Uni-Cage," a printed circuit card enclosure. The unit designed for use with standard off-the-shelf connectors will accept and hold up to 24 cards.

Circle 289 on Inquiry Card

### Meter-Relays

Specs. including dimensions, sensitivities, case styles and prices are included in a catalog on locking contact meter-relays. Bulletin No. 5, 23 pages, 2 colors, includes operating features and standard circuits and is available from Assembly Products, Inc., Chesterland, Ohio.

Circle 290 on Inquiry Card

### Strain Gage Modules

Selection guide for solid state power supplies and transducer control modules for telemetry, data processing and laboratory testing applications is available from Video Instruments Co., Inc., 3002 Pennsylvania Ave., Santa Monica, Calif.

Circle 291 on Inquiry Card

## New Products

### MINIATURE MOTORS

*Small units can be furnished as split series, shunt or split shunt.*

Type GJ wound field dc motors are 1⅜ in. dia. and are furnished in 2 basic ratings: Type GJA is 3 in. long and rated 1/50 HP. at 10,000RPM.; Type GJY is 2½ in. long and is rated 1/100 HP. at 10,000RPM. Both versions are normally furnished split series for 3 wire reversibility with SPDT switch. Max. weight for motor alone is 7.2 oz. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

Circle 223 on Inquiry Card

### PORTABLE OHMMETER

*It offers an accuracy to ½ of 1%.*

These 2 instruments have a built-in precision resistance standard. The Model 244-A Precision Ohmmeter has 4 ranges, allowing direct reading measurements from 0.05Ω to 50KΩ, with a center-scale value of 1.2Ω on the low range. The Model 246-A provides measurement from 0.1Ω to 100KΩ. Both meters have a new indicating meter with a mirrored scale 4½ in. in length. Associated Research, Inc., 3777 W. Belmont Ave., Chicago, Ill.

Circle 225 on Inquiry Card

### VHF-UHF NOISE GENERATOR

*Measures receiver and amplifier noise factor from 30 to 1000 MC.*

It is a portable compact instrument measuring 10⅓ x 7¾ x 10 in. and weighs 20 lbs. The noise figures between 0 and 20 db can be read directly on the front panel meter. Power requirements for the PRD 904-A noise generator are 115 v., 60 CPS and 60 w ac. Two other versions are available on special order. PRD Electronics, Inc., sub. of Harris-Intertype Corp., 202 Tillary St., Brooklyn 1, N. Y.

Circle 224 on Inquiry Card

# Tech Data
## for Engineers

### Component Tester

Manual R-73 contains information useful in the design and application of automated test facilities for cables, components, and completed assemblies. Information is included on facilities for determining continuity, resistance, leakage current and dielectric strength of electrical and electronic devices. Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill.

Circle 292 on Inquiry Card

### Optical Terminology

The first in a series of continuing terminology glossaries, "Glossary of Optical Terminology," covers a wide range of technical terms from "aberrations" to "surface reflection." Available from Servo Corp. of America, 111 New South Rd., Hicksville, L. I., N. Y.

Circle 293 on Inquiry Card

### Instrument Catalog

This 40-page, 2-color instrument and components catalog SJ-61, describes a complete line of r-f instruments and coaxial components; gives characteristics, dimensions, and prices of slotted lines, tapered reducers, instrument loads, impedance-matching tuners and networks, coaxial switches, matching tees, detector-mixer, transmission-line hybrids, and automatic impedance plotters. Alford Mfg. Co., Inc., 299 Atlantic Ave., Boston 10, Mass.

Circle 294 on Inquiry Card

### Transmission Line Testing

Application Note No. 53, 6 pages, describes a pulse-reflection technique for giving a direct reading of transmission line characteristic impedance with a sampling oscilloscope. Available from Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.

Circle 295 on Inquiry Card

### Rotary Solenoid

Bulletin C-961, describes rotary solenoids and rectifiers. This 32-page, 3-color bulletin includes construction and operation information, how to determine size and wire gauge, includes dimensional drawings and complete specs. for stock as well as made-to-order solenoids. Tech data sheets are also available on a miniature rotary pneumatic actuator featuring low displacement, and rapid action, and a silicon bridge rectifier which features no PIV rating because the LEDEX® Transit Control is built into it and spikes are automatically clipped at 200v. on the ac or dc sides. Ledex Inc., 123 Webster St., Dayton 2, Ohio.

Circle 296 on Inquiry Card

# New Tech Data for Engineers

## Digital Circuitry

Interstate Electronics Corp., sub. of Interstate Engineering Corp., 707 E. Vermont Ave., Anaheim, Calif., is offering a 68-page handbook covering applications of digital circuitry. Titled "Digital Application Notes," the book includes chapters on Basic Logic Design Principles, Graphic Symbols, Logic Modules, and Circuit Configurations. Section II included diagrams of the new logic symbols now in use as outlined by Mil-STD-808(USAF).

Circle 297 on Inquiry Card

## Servo Components

A 16-page catalog offering a complete line of size 5 motors, motor tachometers and synchros; a size 8 line, including synchros and resolvers; a size 11 line including synchros and resolvers; and size 15 and 18 lines is available from Daystrom, Inc., Transicoil Div., Worcester, Pa. The catalog gives outline drawings, tabulation of electrical characteristics and information on transistorized servo amplifiers. Photographs and curves included.

Circle 298 on Inquiry Card

## Transducer

This 12-page bulletin contains the Theory and Application of ATCO-TRAN Linear Variable Differential Transformers for measuring linear displacements, along with pricing, engineering, and installation instructions. Bulletin 6208 available from Automatic Timing & Controls, Inc., King of Prussia, Pa.

Circle 299 on Inquiry Card

## Resistors

New power metal film resistors which feature inherent stability and the ability to withstand severe environmental conditions are described in bulletin P-9 available from International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. The 3 and 4w. units were developed for most low power resistor needs and are available at wire wound prices.

Circle 300 on Inquiry Card

## Systems Brochure

This 18-page, 3-color brochure describes Consolidated Systems Corp.'s capabilities and facilities in the fields of automatic data recording and monitoring, automatic power plant control; automatic metal rolling; automatic data handling systems; thin Photo-Optical division and printed circuits facility. Consolidated Systems Corp., 1500 So. Shamrock Ave., Monrovia, Calif.

Circle 301 on Inquiry Card

## Vibration Control

"LORD® fibration/shock/noise control," 16-page, 3-color brochure describing the origin, products, facilities and sources of Lord Mfg. Co., Erie, Pa. Information is included on their mounting systems, flexible couplings, special elastomer products, and Dyna-damp, a laminate with built-in dampening.

Circle 302 on Inquiry Card

## Flutter

A 12-page booklet entitled "FLUTTER: Its nature, cause, and avoidance" presents a study of the phenomenon of flutter and its associated disturbances: wow and drift. Basic theory is followed by a discussion of flutter measurement, causes, avoidance and anti-flutter maintenance. Amplifier Corp. of America, 398 Broadway, New York 13, N. Y.

Circle 303 on Inquiry Card

## Transistor Amplifiers

Tech data on a newly developed circuit for increasing the high-freq. circuit gain by more than 20db in some instances and, in addition, is said to reduce interstage matching problems, improve selectivity and stability and reduce circuit costs is available from Motorola Semiconductor Products Inc., 5005 E. McDowell Rd., Phoenix 8, Ariz.

Circle 304 on Inquiry Card

## Pre-printed Symbols

A money and time saving item, STANPAT tri-acetate sheets are coated with a water-clear adhesive and are pre-printed with repetitive symbols. Tech data describes the line of stock symbols and the custom printed service offered. Custom symbols of any type and detail are possible. STANPAT Co., Whitestone 57, N. Y.

Circle 305 on Inquiry Card

## Recording Controllers

Bulletin GEA-6887A, 12 pages, describes a complete line of single and multi-pen null balance recorders and recorder-controllers. Also discussed are multi-point recorders and multi-purpose indicators. General Electric Co., Schenectady 5, N. Y.

Circle 306 on Inquiry Card

## Waveguides

Catalog M Supplement available from Andrew Corp., P. O. Box 807, Chicago 42, Ill., contains complete electrical and mechanical characteristic information on 9 commonly used sizes of waveguides for use in microwave freqs. Bulletin 8483.

Circle 307 on Inquiry Card

# Tech Data

## for Engineers

### Microwave Components

Specs. and uses are detailed in tech data from the Instrument Div., LFE Electronics Inc., Dept. 1079, 714 Beacon St., Boston 15, Mass., on precision microwave instruments and components. Information is included on their Series 814A and 816-L ultrastable microwave oscillators; Series 820XLK crystal locked klystron oscillators; and Model 240 disturbance waveform analyzer.

Circle 308 on Inquiry Card

### Monitor System

Four of the latest model systems for monitoring radioactivity are shown in Bulletin M-62 offered by Nuclear Measurements Corp., 2460 N. Arlington Ave., Indianapolis 18, Ind. One system is for detecting radioactivity from airborne particulates; others are for monitoring an area, a liquid, or a gas. Systems may be operated singly or together.

Circle 309 on Inquiry Card

### Gyro Test Equipment

Static and dynamic test equipment for complete performance evaluation of gyros, accelerometers, and similar instruments are described in a 7-page catalog available from Micro Gee Products, Inc., 6319 W. Slauson Ave., Culver City, Calif. Included are tech data sheets on static tilt tables, linear acceleration tables, oscillating rate tables and other instruments.

Circle 310 on Inquiry Card

### Connectors

Two connectors for rigid coaxial transmission line are described in tech data available from Technical Appliance Corp., Sherburne, N. Y. The EIA flange is precisely machined for accurate alignment to minimize r-f discontinuity. The new Quick-Clamp connector has a single nut and clamp design for fast assembly or disassembly. Either type may be pressurized.

Circle 311 on Inquiry Card

### Microwave Diode Guide

Containing electrical characteristics and performance ratings of a wide range of microwave mixer, detector, varactor, tunnel and switching-diodes, this 26-page illustrated brochure is available from Sylvania Electric Products Inc., Semiconductor Div., 100 Sylvan Rd., Woburn, Mass. Also featured is a 4-page replacement guide insert, complete listing of mechanical and environmental test procedures, and more than 6 pages, of microwave diode applications notes.

Circle 312 on Inquiry Card

# Tech Data

## for Engineers

### Power Supply Tester

EECO 705 Dynamic Load is a variable-freq. load designed primarily for measuring the internal ac impedance of most dc power supplies and used in transistor equipment. Data sheet includes complete specs. and photographs, hook-up and test set hook-up. Electronic Engineering Co., 1601 E. Chestnut Ave., Santa Ana, Calif.

Circle 313 on Inquiry Card

### Reference Cavities

Catalog CF-61, 4 pages, contains information on 5 stock design cavities covering the freq. range of 9250 to 9312MC. Electrical and mechanical specs, applications and environmental limits are detailed. Microwave Development Laboratories, Inc., Natick, Mass.

Circle 314 on Inquiry Card

### Band Filters

Sigma Electronics Research Corp., 15735 Ambaum Blvd., Seattle 66, Wash., has tech data available on their Series BPF bandpass filters. The BPF series are strip transmission line type unit constructed in multiple sections for sharp skirt selectivity. Performance includes nominal 2db insertion loss in passband with peaks not exceeding 3db and greater than 60db insertion loss from dc to $f_o$.

Circle 315 on Inquiry Card

### Noise Control

"The Why and How of Noise Control" discusses fundamentals of industrial noise control. The 16-page booklet shows how to set up a noise control program and the equipment needed in setting up the program. H. H. Scott, Instrument Div., Dept. "P," 111 Powdermill Rd., Maynard, Mass.

Circle 316 on Inquiry Card

### Voltmeter

Potentiometric Voltmeter Model 951 is described in a 4-page, 3-color tech bulletin available from Smith-Florence Inc., 4228 23rd Ave. W., Seattle 99, Wash. Specs. include input voltage and power, 117v. 60CPS, 1$\phi$, 10w.; potentiometer accuracy, 0.005%; instrument accuracy, 0.01% typical 0.02% absolute.

Circle 317 on Inquiry Card

### Large Antennas

Catalog D covering large parabolic antennas featuring their new patented HUBLOC construction is available from Andrew Corp., P. O. Box 807, Chicago 42, Ill. Specs. on 28 and 60 ft. dia. reflectors are given with information on antenna feeds, reflector surfaces, supports, mounts and radomes.

Circle 318 on Inquiry Card

### Generators

Fallout shelter generators are described in a booklet entitled "Kohler Electric Plants for Fallout Shelters." This 2-color, 4-page folder describes various models and sizes of Kohler generator sets suitable for fallout shelter installation, and how and where to install them. Kohler Co., Kohler, Wis.

Circle 319 on Inquiry Card

### Resistor Catalog

Precision Wirewound Resistor Catalog, 20 pages covers a complete line of Hi-Q units. Included are performance characteristics, Mil spec. information on encapsulated units with axial and radial wire terminals, turret lug and radial lug terminals, and Hi-Q micro-miniature series. Hi-Q Div., Aerovox Corp., 1100 Chestnut St., Burbank, Calif.

Circle 320 on Inquiry Card

### Power Supplies

This "Master Power Supply Chart" contains specs. on all laboratory dc power supplies and ac line regulators. The notebook-size fold-out chart is 3-ring-punched, and lists such information as output, regulation ripple, impedance, dimensions, and price. Perkin Electronics Corp., 345 Kansas St., El Segundo, Calif.

Circle 321 on Inquiry Card

### Power Control Units

Characteristics, operational details, and applications of power control units are discussed in a new 8-page bulletin available from Magnetic Inc., Butler, Pa. Control units are rated from 1 to 15KVA and are used for proportioning or switching of power, ac or dc to a variety of loads. Included are photographs, characteristic curves and circuit diagrams for the various units.

Circle 322 on Inquiry Card

### Power Supplies

Pacific Electric Motor Co., 1009 66th Ave., Oakland 21, Calif., has tech data available on their "Q" line transistorized solid state power supplies. Specs. include current regulation, $1 \times 10^{-6}$; drift, $1 \times 10^{-4}$ after warm-up; and for low impedance type magnet load, approx. 0.5 to 2$\Omega$ loads. Units range from 5 to 50KW.

Circle 323 on Inquiry Card

### Power Klystrons

Tech data is available on power klystrons, tetrodes, pentodes, triodes, pulse modulators, diodes, rectifiers, a diffusion pump, ionization gauge, and heat dissipating connectors from Eitel-McCullough, Inc., San Carlos, Calif. Photographs, characteristic charts and complete listings of both electrical and mechanical characteristics are included.

Circle 324 on Inquiry Card

# Tech Data

## for Engineers

### Tantalum Capacitors

For use in transistor, missile, communication or similar circuitry, Good-All's 901 solid, polar tantalum capacitors are rated from 0.0047 to 330mf., and 6 to 35vdc. Bulletin No. 1061 includes photographs, instruction information, characteristics, charts and complete specs. Good-All Electric Mfg. Co., sub. of Thompson Ramo Wooldridge, Inc., Ogallala, Nebr.

Circle 325 on Inquiry Card

### Signal Recording

Two, 22-page Technical Reviews entitled "RMS Recording of Narrow Band Noise with a Level Recorder" and "Effective Averaging Time of an RMS Level Recorder," include information on the influences in the level recorder that affect the measurement of the theoretically true RMS value of a statistically fluctuating signal. Copies of TR-4-60 and TR-1-61 may be obtained by B & K Instruments, Inc., 3044 W. 106th St., Cleveland 11, Ohio.

Circle 326 on Inquiry Card

### Electronic Equipment

Semler Industries, Inc., 6919 Lankershim Blvd., N. Hollywood, Calif., is offering tech. data on their radio sets, their radio transmitters, pressurizing kit, radio test sets, voltage dividers, aircraft cameras, processing units, wattmeters, signal generators, and test oscillators.

Circle 327 on Inquiry Card

### RFI Suppression

United Control Corp., Seattle 5, Wash., is offering a facility brochure describing their capabilities in the area of radio frequency interference suppression. Photographs are included of their plant, their line of instrumentation, and filters.

Circle 328 on Inquiry Card

### Vacuum Pumping System

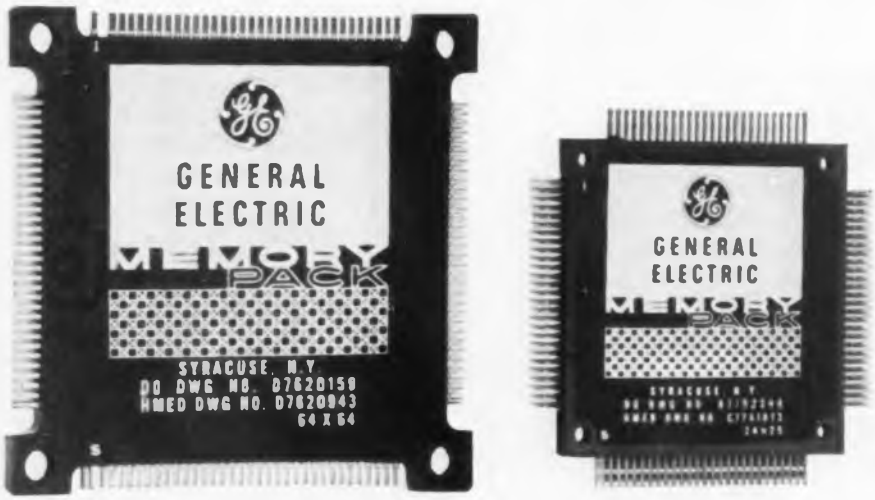
Vacuum Apparatus Co., Sub. of National Research Corp., P. O. Box 1001, Palo Alto, Calif., has available tech. data on their high-speed performance 4 in. very high vacuum pumping system. Description, photographs, characteristics, charts, schematics, and specs are included.

Circle 329 on Inquiry Card

### Magnetic Sensing

F. W. Bell Inc., 1356 Norton Ave., Columbus 12, Ohio, is offering tech data on their Model BH200 Transverse Field Hall-Pak, Hall Effect Device and their Model BH203 Axial Field Hall-Pak, Hall Effect Device. Featured are low noise output and high temp. operation.

Circle 330 on Inquiry Card




## *General Electric Ferrite Core Memory Planes . . . Encapsulated for Reliability*

Modern military and industrial computers must frequently be designed to operate in severe environmental conditions of shock, vibration, and corrosive atmospheres. Wherever these requirements exist, General Electric's encapsulated Ferrite Core Memory Planes can contribute to the reliability of your equipment designs.

Designed to operate in vibration environments of 25Gs or more, these memory planes are available in individual plane sizes up to 64 by 64 bits. Stacking technique permits assembly of large capacity memory systems for ground or airborne applications.

A variety of electrical performance characteristics is offered through a selection of ferrite core types to meet individual customer specifications. Open memory planes are also available for lower cost commercial applications. ***Specialty Devices Operation of Defense Electronics Division, General Electric Co., Lemoyne Avenue, Syracuse, N. Y.***

### *Let us tell you all about them.*

Section B171-01 General Electric Co., Schenectady, N. Y.

☐ Please send me the specification sheet for G-E Ferrite Core Memory Planes.

☐ Please send me specification sheets for complete line of G-E Integrated Electronic Devices.

NAME_____ TITLE_____

COMPANY_____

CITY_____ STATE_____

**GENERAL ELECTRIC**

# International Electronic Sources

*Up-to-the-minute abstracts of articles appearing in the leading foreign electronic engineering manuals*

## CIRCUITS

**Generalized Graphical Method for Design of Switching Circuits,** V. N. Roginsky. "Avto. i Tel." March 1961. 9 pp. A generalized graphical method for designing switching (p, k) circuits, round-about ways being taken into consideration. (U.S.S.R.)

**Amplitude Stabilizing Devices for High Frequency Voltages.** A. A. Lvovich. "Radiotek" 16, No. 6, 1961. 9 pp. This article deals with aspects of voltage amplitude stabilization of amplifier circuits in the high frequency and audio frequency range. Stabilization is achieved by automatic control of the voltage transmissibility coefficient from the input with a thermistor. Formulae are derived for the calculation of the amplitude stabilization coefficients of the output voltage under the action of various destabilizing factors. Conditions are established for thermal compensation of amplitude variations of the stabilized voltage. (U.S.S.R.)

**Cathode Coupled Cascode Stabiliser Circuit,** S. G. Jones and R. S. McClean. "Elec. Eng." Aug. 1961. 3 pp. An amplifier circuit with high gain and relatively low phase-shift allows the design of a high performance negative high-voltage supply in which stability is easily achieved. (England.)

**A Solid-State DC Amplifier with Floating Input and Low Drift.** I. C. Hutcheon and D. Summers. "Elec. Eng." Sept. 1961. 5 pp. The solid-state chopper-type dc amplifier is described whose input, output and supply terminals are isolated electrically from each other and from the chassis. (England.)

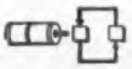
**A Wide Dynamic Band Video Amplifier.** V. M. Volkoff. "Radiotek" 16, No. 8, 1961. 8 pp. Basic conditions are given which characterize the sequential operation of non-linear stages of an n-stage logarithmic amplifier. Design and experimental data of a new video amplifier circuit are also given. This new amplifier provides an exact logarithmic amplitude characteristic in a broad dynamic band. (U.S.S.R.)

## COMPUTERS

**Analog Computer "Unimar,"** H. Kirst. "El. Rund." Aug. 1961. 5 pp. Properties and features of the analog computer "Unimar" are described. The medium-size computer comprises 42 linear and 20 nonlinear arithmetic units and 2 down-time models. The first "Unimar K" has been in operation there since mid 1959. (Germany.)

**To Problem of Digital Reproduction of Analog Telemetering System Signals,** A. Kupershmidt. "Avto. i Tel." Aug. 1961. 8 pp. Advantages and ways of realizing digital reproduction of analog telemetering system signals are explained. (U.S.S.R.)

**Analysis of Self-Oscillations due to Level Quantization of Signal in Automatic Digital Systems,** M. Korshunov. "Avto. i Tel." July 1961. 11 pp. A method based on application of a describing function principle is suggested for determination of amplitude and frequency of self-oscillations which are roused by level quantization of a signal in automatic digital systems. (U.S.S.R.)



## CONTROLS

**High Speed and High Precision Sampled Data Servomultiplier,** S. Barabaschi and R. Tasselli. "Alta Freq." July 1961. 2 pp. This paper describes a sampled-data servomultiplier developed by the CNEN Servomechanisms and Control Laboratory. (Italy, in English.)

**To Problem of Determination of Stability Limit for Non-linear Control Systems,** A. K. Bedelbaev. "Avto i Tel." July 1961. 8 pp. Determination of boundaries of a region in which a non-linear automatic control system is stable is suggested. (U.S.S.R.)

**Industrial Remote Control System SRP-3,** M. G. Geshelin, et al. "Avto i Tel." July 1961. 4 pp. An industrial remote control two-frequency-combination code system using tone frequency range is described. (U.S.S.R.)

**Modern Tendency of Development of Dispatcher Control Based on Application of Digital Technique,** A. Kupershmidt, et al. "Avto. i Tel." July 1961. 6 pp. Principles of constructing dispatcher control systems based on application of digital technique in the information transfer and reproduction as well as in its processing at the control center are considered. (U.S.S.R.)

**Analytical and Structural Description of Mechanical Transmissions in Automatic Control Systems with Restrictions and Backlashes,** G. Litovchenko, P. Yakovenko. "Avto. i Tel." Aug. 1961. 8 pp. The method for describing backlashes and restrictions in mechanical transmissions of automatic control systems is considered. (U.S.S.R.)

**Conditions of Overshooting Absence in Some Non-linear Control Systems,** G. M. Ostrovsky. "Avto. i Tel." Aug. 1961. 6 pp. The method of finding conditions of overshooting absence for some non-linear systems is given. (U.S.S.R.)

**On Absolute Stability of Non-Linear Automatic Control Systems,** V. M. Popov. "Avto. i Tel." Aug. 1961. 19 pp. The problem of absolute stability of an indirect control with one nonlinearity is analysed by a special method which differs from the second method of Liapounoff. (U.S.S.R.)

**Automatic Control of Strip Thickness by Strip Thickness Vibrations,** Tsui Shou-De. "Avto. i Tel." Aug. 1961. 6 pp. A new system for automatic control of a strip thickness by strip thickness vibrations is described. The circuit and the results of its experimental investigation are given. (U.S.S.R.)

## REGULARLY REVIEWED

**AUSTRALIA**

AWA Tech. Rev. AWA Technical Review
Proc. AIRE. Proceedings of the Institution of Radio Engineers

**CANADA**

Can. Elec. Eng. Canadian Electronics Engineering
El. & Comm. Electronics and Communications

**ENGLAND**

ATE J. ATE Journal
BBC Mono. BBC Engineering Monographs
Brit. C.&E. British Communications & Electronics
El. Tech. Electronic Technology
GEC J. General Electrical Co. Journal
J. BIRE. Journal of the British Institution of Radio Engineers
Proc. BIEE. Proceedings of Institution of Electrical Engineers
Tech. Comm. Technical Communications

**FRANCE**

Bull. Fr. El Bulletin de la Societe Francaise des Electriciens
Cab. & Trans. Cables & Transmission
Comp. Rend. Comptes Rendus Hebdomadaires des Seances
Onde. L'Onde Electrique
El. et Auto. Electronique et Automatisme
Rev. Tech. Revue Technique
Telonde. Telonde
Toute R. Toute la Radio
Vide. Le Vide

**GERMANY**

AEG Prog. AEG Progress
Arc. El Uber. Archiv der Elektrischen Uebertragung
El Rund. Electronische Rundschau
Freq. Frequenz
Hochfreq. Hochfrequenz-technik und Electroakustik
Nach. Z. Nachrichtentechnische Zeitschrift
Rt. Regelungstechnik
Rundfunk. Rundfunktechnische Mitteilungen
Vak. Tech. Vakuum-Technik

**POLAND**

Prace ITR. Prace Instytutu Tele-I Radiotechnicznego
Roz. Elek. Rozprawy Electrotechnizne

**USSR**

Avto. i Tel. Avtomatika i Telemekhanika
Radio. Radio
Radiotek. Radioteknika i Elektronika
Rad. i Elek. Radioteknika i Elektronika
Iz. Acad. Bulletin of Academy of Sciences USSR

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# International ELECTRONIC SOURCES

## GENERAL

**The Choice and Design of DC Convertors.** J. S. Bell, P. G. Wright. "Elec. Eng." April 1961. 6 pp. The design of single and two transformer convertors is discussed and their performances compared. Design steps are indicated and two practical designs are worked out as examples. (England.)

**To Functional Potentiometer Design.** V. M. Frygin. "Avto. i Tel." April 1961. 4 pp. Methods for designing functional potentiometers on non-profiled frameworks are described. A graphical method for designing functional potentiometers is given. (U.S.S.R.)

**Relays—Some Informal Notes and Opinions, Part II.** G. L. Brown. "Brit. C. & E." May 1961. 4 pp. The first part of this article dealt with the general characteristics of relays and the way in which specifications for them ought to be decided. The article is concluded this month with a discussion of such things as operate time, power dissipation, and testing. (England.)

**Optimal Matching of Symmetrical Low- and High-Pass Filters Application to Low- and High-Pass Piezoelectric Crystal Ladder Filters.** J. E. Colin and P. Allemandou. "Cab. & Trans." April 1961. 16 pp. It is shown that there exists another limit value of the attenuation ripple, together with another corresponding filter structure whose merits are by no means lesser than the first's. (France.)

**Relays—Some Informal Notes and Opinions, Part I.** G. L. Brown. "Brit. C.&E." April 1961. 4 pp. This article, the second half of which will be published next month, is not meant to be a rigorous treatment; the science of the subject has been dealt with elsewhere. However, it is felt that this particular approach will assist those who do not design relays, but nevertheless have to apply them to their own apparatus. (England.)

**Qualifications for Electronics.** C. M. Cade. "Brit. C.&E." April 1961. 11 pp. An analysis is presented of the various paper qualifications which are commonly accepted by employers as being the equivalent of a University Honors Degree or University Pass Degree. (England.)

**Survey Shows Broadcasters' Needs.** Harold Price. "Can. Elec. Eng." April 1961. 2 pp. Canadian Electronics Engineering has recently completed a survey in which a questionnaire was sent to all of Canada's private broadcasting stations and to CBC headquarters. Here are the results of the survey in a condensed report. (Canada.)

**Determination of Optimum Parameters of Some Types of Magnetic Logic Elements.** N. P. Vasilieva and L. Gashkovets. "Avto. i Tel." July 1961. 15 pp. There are determined correlations between core parameters with maximum gain of reactor magnetic logic elements when maximum power and heating restrictions take place; conditions necessary to get stable characteristics are taken into consideration. (U.S.S.R.)

**Band-Pass Filters Having Quasi-Symmetrical Attenuation and Group-Delay Characteristics.** F. Carassa. "Alta Freq." July 1961. 12 pp. The problem of obtaining the maximum possible symmetry for the above characteristics is considered and generally solved for the physically realizable band-pass transfer functions, having all zeros at zero and infinite frequencies. The structures of the filters having quasi-symmetrical characteristics are then illustrated and the design procedures are given for maximal attenuation flatness. (Italy, in English.)

**Electric Model of Water Channel.** S. Bellert, et al. "Roz. Elek." Vol. 7, #1. 22 pp. The paper is concerned with the examination of analogy between Saint-Venant's simplified equations portraying dynamics of water motion in a channel and those of the long electric lines. (Poland.)

**Brightness Discrimination of Signals with a Noise Background.** I. L. Zelmanovitch. "Radiotek" 16, No. 8, 1961. 6 pp. The dependence of the brightness discrimination of signals with a noise background on the threshold of contrast is analyzed. (U.S.S.R.)

**Response of a Low Frequency Filter with a Trapezoidal Frequency Characteristic and Linear Phase Characteristic To Certain Signals.** H. I. Tcherne. "Radiotek" 16, No. 6, 1961. 10 pp. A response is derived of a low frequency idealized filter with a trapezoidal amplitude-frequency characteristic and a linear phase frequency characteristic to the following inputs: a step input voltage, a rectangular pulse and a sine square pulse. (U.S.S.R.)

**Processes in High Order Frequency Multipliers.** S. I. Yevtianoff, M. V. Kapranoff. "Radiotek" 16, No. 6, 1961. 11 pp. A method to determine the envelope of the output voltage in a high order frequency multiplier ($10 < n < 100$) is developed by slowly varying amplitudes. This frequency multiplier is excited by pulses of short duration. Two typical multipliers, one with a singular wave form loading, the other with a bandpass filter loading, are used to illustrate the influence of the order of the selected harmonic, attenuation and contour detuning on the form of the waveform envelope. (U.S.S.R.)

**Mass Spectrometer Investigations in the Ultra-High Vacuum.** P. Jahn and J. Zahringer. "Vak. Tech." June 1961. 4 pp. A very sensitive mass spectrometer was used to investigate the composition of the residual gas in a vacuum system, as obtained with oil diffusion pumps plus non-refrigerated baffles, and with an ion-getter-pump. (Germany.)

**Thermal Design of Resonant Ferrite Rectifiers.** M. V. Vambergsky, T. V. Shelukhina. "Radiotek" 16, No. 7, 1961. 11 pp. The authors analyze thermal effects taking place in resonant ferrite rectifiers operating at medium and high power levels. They investigate the temperature distribution throughout the volume of ferrite samples and the variation of the continuous magnetic field caused by ferrite heat dissipation. (U.S.S.R.)

**Orientation of Bats and Men by Ultrasonic Echo Location.** L. Kay. "Brit. C.&E." Aug. 1961. 5 pp. For many years the ability of bats to catch insects on the wing using ultrasonic waves has puzzled workers in this field of research. A way in which they may do this is suggested in this article and it has been found that a model to demonstrate the theory may form the basis of a Blind Guidance Aid. (England.)

**How to Maintain a Complex Electronic System.** Thomas R. Darmody. "Can. El. & Comm." July 1961. 5 pp. Efficient maintenance makes the difference between smooth operation and unpredictable shutdowns. The bigger and more complex an electronic installation is, the more precise the maintenance program must be in plan and execution. (Canada.)

**The Trend is to Simplicity in Modern Intercommunication Systems.** J. G. Mager. "Can. El. & Comm." July 1961. 3 pp. Communications equipment designers have cleared the executive's desk of a battery of telephones and have provided him with one unit capable of handling all his varied communications needs. (Canada.)

**Variations of the 2T-RC Filter.** V. L. Zmudikoff. "Radiotek" 16, No. 8, 1961. 7 pp. Variations of the T-RC filter, with conductances between its various nodes, are analysed. It is proved that under these conditions, it is possible to tune the filter to obtain zero transmission coefficient at quasi-resonance. (U.S.S.R.)

**To Problem of Choice of Control Part Parameters for Automatic Optimization Gradient Systems.** T. I. Tovstukha. "Avto. i Tel." Aug. 1961. 11 pp. Control part parameters of an automatic optimization gradient system with one or several independent inputs are selected taking account of the fact that the steady value of output signal mathematical expectations must be small enough. (U.S.S.R.)

**Automatic Programming System for Machine Tools.** B. G. Tamm. "Avto. i Tel." Aug. 1961. 18 pp. Automatic calculation of supporting points for a linear-circle interpolator by contours consisting of lines and circle arcs is considered. (U.S.S.R.)

**Automatic Optimization of Space Distribution III.** L. N. Fitzner. "Avto. i Tel." Aug. 1961. 11 pp. Design principles for apparature aimed for automatic synthesis of automatic optimization systems of space distribution which were considered in (1) are explained. (U.S.S.R.)

**Determination of Optimum Characteristics of Extremal Systems with Random Disturbances. I.** N. V. Grishko. "Avto. i Tel." Aug. 1961. 14 pp. The paper deals with the investigation of an extremal system described in (1). The investigation is based on the analytical expression of a system quality criterium which is obtained in the paper. (U.S.S.R.)

**A Fourier Transform Generator.** G. F. Newell and W. K. E. Geddes. "Elec. Eng." Sept. 1961. 6 pp. An electronic device is described which, when coupled to a suitable oscilloscope, will display the sine or cosine-transform of any function capable of being represented at least approximately by not more than 41 ordinates spaced at equal intervals of the variable. (England.)

**A Fast Numeral Reading Machine.** G. Fougere, et al. "Elec. Eng." Sept. 1961 4 pp. The purpose of this machine is to read groups of 3 decimal digits which have been impact-printed on special foam plastic tape. Printing increases the transmission of light through the tape by about 30 times and recognition is obtained by a two-dimensional array of solar cells. (England.)

**Determination of Core Size in Pulse Transformer Design.** C. F. Wilds. "Elec. Eng." Sept. 1961. 8 pp. The article is concerned with pulse transformers designed to accept rectangular pulses and having a high, or moderately high set-up turns ratio. (England.)

**Description of Multi-Dimensional Linear Systems in Matrix Form.** I. Matyas and Y. Silhanek. "Avto. i Tel." July 1961. 9 pp. Matrix relations are deduced which describe the behavior of multi-dimensional linear systems. (U.S.S.R.)

**Some Applications of Contact Grids.** A. Svoboda. "Avto. i Tel." Aug. 1961. 10 pp. The paper shows how to use contact grids to find a minimal form of a given Boolean function. (U.S.S.R.)

**Concerning Generating Method for Random Processes with Given Matrix of Spectral Densities.** I. Matyash, et al. "Avto. i Tel." March 1961. 3 pp. The method is illustrated by examples of generating descrete random processes and continuous random processes with time-delay. (U.S.S.R.)

**The Lightweight Submarine Telephone Cable.** R. A. Brockbank. "Brite. C.&E." April 1961. 4 pp. The steel wire armour applied to all submarine cables since the first Transatlantic telegraph cable in 1866 has many serious disadvantages particularly when used on telephone cable with heavy rigid repeaters inserted at frequency intervals. The new lightweight cable described in this article not only overcomes these difficulties but confers many additional benefits. (England.)

**A Current Regulator and Sweep Mechanism for the Electromagnet in Paramagnetic Resonance Experiments.** E. W. Collings. "El. Tech." April 1961. 3 pp. A simple regulator and sweep mechanism for controlling the output of a dc generator is described. (England.)

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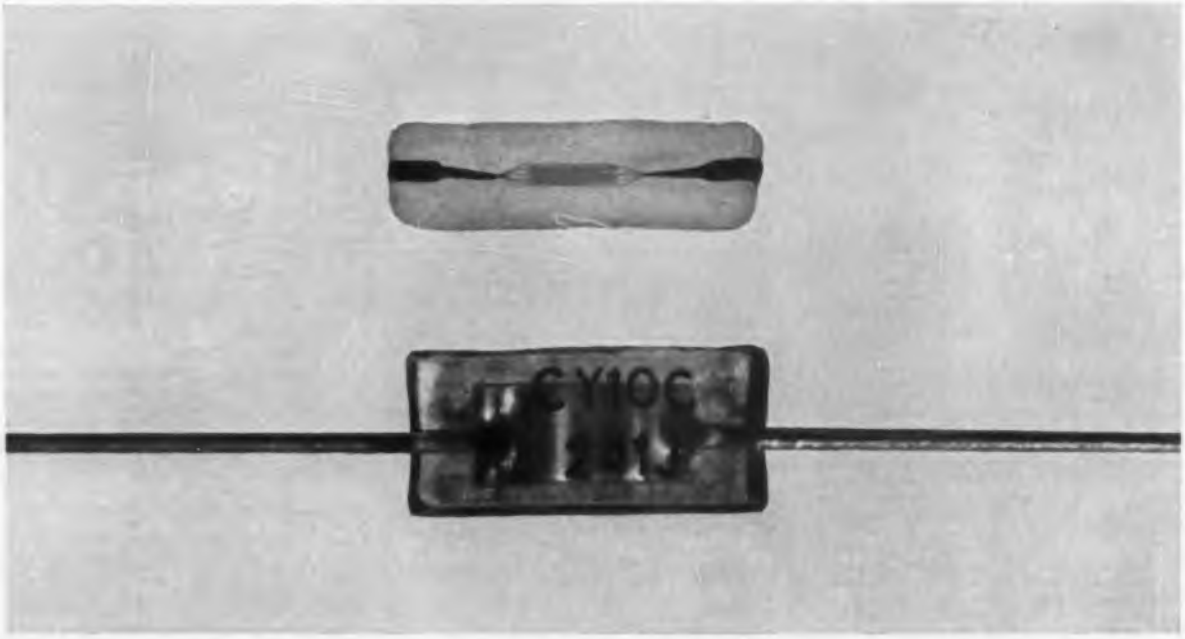


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# *International* ELECTRONIC SOURCES

**A Backward Wave Oscillator for the Frequency Range 10,000-20,000 Mc/s with a Delay Line Consisting of Circular Fingers,** W. Wendrich. "Nach. Z." April 1961. 9 pp. A delay line with circular fingers has been developed for the design of a backward wave oscillator operating in the frequency range 10,000-20,000 Mc/s. Its advantage is a stronger stray field with which the electron beam can interact. A particularly short and effective field absorber made from graphite is used as a reflectionless termination for this delay line. (Germany.)

**A High Speed DC-AC Servo Drive Unit,** R. A. Unvala, B. T. Denvir. "Elec. Eng." April 1961. 5 pp. The prototype servo unit described was required to operate a 10W ac servo motor from a low voltage input over the frequency range dc to 70 c/s. The circuit comprises a diode ring modulator switched at 400 c/s, followed by an ac amplifier incorporating phase-shift and limiter networks. The modulator uses silicon rectifiers and the amplifier is completely transistorised using silicon transistors throughout. The power supply circuit is also described. (England.)

**Two-Phase Sensitive Magnetic Modulator,** F. I. Kerbnikov, M. A. Rosenblatt. "Avto. i Tel." March 1961. 7 pp. The circuit and theory of a magnetic modulator with perpendicular magnetic fields are described. (U.S.S.R.)

**Contactless Switches with Steel-E310 Magnetic Cores,** K. G. Mitjushkin. "Avto. i Tel." March 1961. 10 pp. Magnetic contactless pulse switches with standard steel-E310 (HVP) cores are described. Theoretical data and parameters are given for some switches designed both on the basis of a single-way circuit and on the basis of a double-way one. (U.S.S.R.)

**The Initial Conditions of Linear Transfer Devices,** O. Follinger. "rt." April 1961. 5 pp. This paper deals with transfer devices which are characterized by the fact that the relationship between the input and the output values can be expressed by a differential equation with constant coefficient. (German.)

**Transductor Grid Control of Mercury-Arc Rectifiers,** Werner Jentsch and Wolfgang Reichelt. "AEG Prog." #7, 1961. 4 pp. In conjunction with the method of operation of a controlled mercury-arc rectifier, the functions of grid control and the requirements which grid-control apparatus must fulfill, are dealt with. Two transductor grid-controls, a saturating and a phase-shifting system are then described. (German in English.)

**Definitions, Terminology and Symbols of Transductor Engineering,** Alfred Long. "AEG Prog." #1, 1961. 6 pp. Definitions and terminology relating to components, applications and characteristics are explained. The terms established represent the results of construction up to the present. (Germany, in English.)

**Magnetic Voltage Stabilizers,** Friedrich Huff and Werner Moch. "AEG Prog." #1, 1961. 2 pp. The method of operation and electrical characteristics of magnetic voltage stabilizers are described. Particulars are given of a type series for powers of 25 to 1500 VA in open and sheet-steel enclosed construction. (Germany in English.)

**Representation of Non-Stationary Linear Differential Operator-Polynomial as a Sum of Stationary Operators,** A. N. Skljarevich. "Avto. i Tel." March 1961. 9 pp. It is shown that an arbitrary non-stationary linear differential operator-polynomial can be represented as a sum of stationary operators with corresponding nucleus. An algorithm is given which makes it possible to get all components of this representation. (U.S.S.R.)

**Concerning Design of Push-Pull Magnetic Amplifiers,** V. L. Benin. "Avto. i Tel." March 1961. 7 pp. As an addition to the design method for push-pull magnetic amplifiers given there are deduced correlations which permit to immediately determine optimum parameters of push-pull magnetic amplifiers with accuracy defined by an accuracy of the linearized magnetic amplifier theory, successive approximations being unnecessary. (U.S.S.R.)

## INDUSTRIAL ELECTRONICS

**Production Techniques for Epoxy Filled Wire Spring Relay Coil Assemblies,** H. L. Miller. "Can. El. & Comm." July 1961. 2 pp. The article describes how Northern Electric engineers solved the production problems in the manufacture of improved telephone relays. (Canada.)

**Improvement on Oxide Cathode Stability by Controlled Electrolysis,** Aurelius Sandor. "Vide." May-June 1961. 12 pp. A one-step activation schedule for oxide cathodes is worked out which gives optimum space charge protection against field penetration. (France in English.)

## MATERIALS

**Status of Development of Ferrites and Their Application,** H. Severin. "El Rund." June 1961. 6 pp. Ferrites are magnetic oxides containing iron as the essential metal component. Their resistivity is $10^{10}$ to $10^{18}$ times that of iron. The paper offers a brief survey of the magnetic materials and their properties and discusses the problem of the upper cutoff frequency. (Germany.)

**The Ion Baffle, a New Electric Hydrocarbon Trap For Oil Sealed Rotary Pumps,** R. A. Haefer. "Vak Tech." May 1961. 5 pp. A new electric hydrocarbon trap is described. It is essentially based on the fact that the backstreaming hydrocarbon molecules are transformed in a solid CH-polymer layer by ion impact in an electric cold cathode discharge of the inverse magnetron type. (Germany.)

## MEASURE & TESTING

**Special Cases in Measurements of Mean Values of Homogeneous and Isotropic Random Fields in Two-Dimensional Space.** S. E. Bogdanoff. "Radiotek" 16, No. 8, 1961. 8 pp. A process to determine mean values of homogeneous and isotropic random fields in two dimensional space by integration is analyzed. (U.S.S.R.)

**Transistor Current Gain at U.H.F. Measurement Techniques,** B. N. Harden. "El. Tech." Sept. 1961. 5 pp. A coaxial-line system and a twin-channel comparator are used to determine amplitude and phase variations of current gain. Results in the frequency range 300-800 mc/s are compared with values obtained by a bridge method. (England.)

**Investigations on More Recent Types of Magnetic Sound Tapes,** E. Belger and P. Scherer. "Rundfunk." Aug. 1961. 8 pp. The article discusses the possibility of further improving the quality in sound recording with the tapes at present available. It discusses important phenomena insofar as these can be affected by the recording technique, as well as the appropriate measuring technique. (Germany.)

**A New Double-Channel Meter with Light-Spot Indication,** Arno Rettig. "Rundfunk." Aug. 1961. 5 pp. The article describes an instrument with light-spot indication that produces two independent readings. (Germany.)

**The Frequency-Measurement and Reception Technique of the Norddeutscher Rundfunk, the Scope and Equipment of the Measuring and Receiving Station at Wittemoor,** H. Ehlers and H. Thies. "Rundfunk." June 1961. 11 pp. In addition to supervising the frequency and the modulation of the transmitters of the Norddeutscher Rundfunk, together with the news pick-up and rebroadcasting tasks that are involved, the Frequency and Receiving Technique Dept. also undertakes work for the ARD and the EBU. (Germany.)

**Use of Pulse Counters in the Measurement of the Auto-Correlation Coefficient of Threshold Level Exceeding by a Random Signal,** V. V. Viter, K. V. Kulkov. "Radiotek" 16, No. 6, 1961. 5 pp. A method is considered to calculate the auto-correlation coefficient and the amplitude correlation function of randomly sequenced pulses exceeding a given threshold level. This method is based on the measurement of the mean triggering frequency of the threshold device and its additive components. (U.S.S.R.)

**Method of Plotting Amplitude and Phase Frequency Responses With the Help of Generalized Family of Decibel-Log Characteristics,** D. E. Polonnikov. "Avto. i Tel." June 1961. 9 pp. There is proposed a method of plotting amplitude and phase frequency responses of electrical nets which complex transfer coefficients can be represented in a canonic form. Tables of 28 circuits and formulae are given which connect circuit parameters with parameters of a generalized family of decibel-log characteristics. (U.S.S.R.)

**Depth of Modulation Measurements for Low Level Signals.** K. A. Reznik. "Radiotek" 16, No. 5, 1961. 5 pp. Existing modulation depth measuring devices are useful for high level signals of 10 volts and higher. This article deals with means of measuring the modulation depth of signals of about 1 volt. (U.S.S.R.)

**A Contribution to the Calculating of the Frequency Response of Relay Systems,** J. Tschauner. "Rt." May 1961. 4 pp. A method derived by Zypkin for the calculation of the frequency response of relay systems without dead band and without saturation is extended to cover relay systems with dead band and hysteresis, provided discontinuities in the output are acceptable. (Germany.)

**Measuring Q in the Million Range at Millimeter Wave Lengths,** Francesco Parisi. "Alta Freq." July 1961. 5 pp. A Q-measuring system is described for measuring Q in the million range, such as occurs in circular waveguide cavity circuits operating in the $H_{01}$ mode, at millimeter wave length. (Italy, in English.)

**The Acoustic Input Impedance of the External Ear,** H. Zwicker. "Nach. Z." August 1961. 8 pp. The acoustic input impedance of the ear during telephone reception has been measured at various frequencies and in each case with at least 30 test persons. The method used employs a transformation of the acoustic load of a transducer into the equivalent electric input impedance. (Germany.)

## SEMICONDUCTORS

**Medical Recording Amplifier,** F. Juster. "El. et Auto." June 1961. 4 pp. This medical amplifier is fully transistorized and uses dc couplings between stages. (France.)

**Applications of Transistors,** R. Duchamp. "El. et Auto." June 1961. 3 pp. This is the third article of a series covering simple applications of transistors. It deals with switching circuits of the bistable type. The fundamentals are briefly reviewed and an elementary analysis is performed on a simplified circuit. (France.)

# *International* ELECTRONIC SOURCES

**Lattice Imperfections in Metal, Semiconductors and Ionic Crystals.** H. G. van Bueren. "Phil. Tech." #11, 1961. 12 pp. In this article, devoted to differences in the behavior of lattice imperfections in various materials, the author discusses the manner in which these imperfections are formed and their influence on the electrical and mechanical properties of the substance concerned. (Netherlands, in English.)

**The Silicon Switching Transistor.** W. Munch and H. Salow. "Nach. Z." Sept. 1961. 5 pp. A suitable design of a switching transistor with storage properties and made from silicon is given. (Germany.)

**High-Speed Multi-Channel Transistor Distributor,** E. Belenky, V. N. Michaelovsky. "Avto. i Tel." Aug. 1961. 6 pp. Multi-phase transistor multivibrator is described in which one transistor is needed to realize one operating pulse. The circuit is designed and possibilities of its application as a high-speed distributor are explained. (U.S.S.R.)

**On "Reversal" Conditions for Relay Semiconductor Devices.** S. V. Kulikov. "Avto. i Tel." July 1961. 5 pp. Determination of "reversal" conditions for relay semiconductor devices is given. The conditions are found from the matrix of the equivalent circuit. (U.S.S.R.)

**The Main Store of a Digital Differential Analyzer,** P. L. Owen, et al. "Elec. Eng." Aug. 1961. 7 pp. This article, the second of a series of four describing the elements of a transistorized digital differential analyzer, deals with the main store. The store consists of a 5a word by 32 digit matrix of ferrite cores. The function of each of the components into which the storage loop may be logically divided is described in detail. (England.)

**The Transistor in Voltage and Current Stabilizers,** Hans Juergen Bederke and Hans Mueller. "AEG Prog." #1, 1961. 6 pp. The basic circuit and method of operation of electronically controlled sources of direct voltage are explained. (Germany in English.)

**Transistors in Preamplifiers for Amplidynes and Magnetic Amplifiers,** Heinz Guenter Lott. "AEG Prog." #1, 1961. 4 pp. The use of transistors as preamplifiers for rotary amplifiers and magnetic amplifiers is illustrated by typical examples. (Germany in English.)

**Photo-Transistors and their Application in Rolling Mills,** Karl Zonder. "AEG Prog." #1, 1961. 5 pp. The behavior of photo-transistors and photo-diodes in photo-electric control systems which have been used by AEG in rolling mills since 1956, is described. (Germany in English.)

**Switching Transistors for the Continuous Control and Regulation of Power.** Wilfried Fritzsche. "AEG Prog." #1, 1961. 5 pp. First the duties of the switching elements in the familiar thyratron control equipments with alternating voltage feed are compared with the considerably less stringent demands made on switching transistors with direct current feed. (Germany in English.)

**Circuit and Static Design of an Electronic-Transistor Trigger.** G. G. Menshikoff. "Radiotek" 16, No. 5, 1961. 4 pp. A principal circuit and a static design are given for a new device with two stable states. This device, consisting of a vacuum tube and a transistor, differs from other known trigger circuits by the simplicity of the circuit, high reliability, and low transistor requirements. (U.S.S.R.)

**Permanent Internal Polarization.** H. Sire. "El. et Auto." June 1961. 1 pg. Free charge carriers are created in semiconductors by certain radiations. Under the action of a magnetic field, polarization effects are produced which can be permanent. (France.)

**Safer Interlocking by Solid State Relays,** F. H. Laishley and M. H. Roberts. "Brit. C & E." July 1961. 4 pp. Safer interlocking control of machinery or signals is offered by this new way of using transistors and ferrite cores in "logic units" to replace relays. (England.)

**A Constant Temperature Transistor Enclosure,** M. W. Rignall. "Elec. Eng." July 1961. 2 pp. A constant temperature enclosure capable of housing twelve OC201 sized transistors is described. (England.)

**Transistors for the Control and Regulation of Static Convertors,** Robert Joetten, et al. "AEG Prog." #1, 1961. 5 pp. As examples of application of transistors for control and regulation of rectifiers, a steplessly controlled dc amplifier, a switching amplifier with pulse-width control and a grid-control set for mercury-arc rectifiers are described. (Germany in English.)

**Precision Transistor Integrator.** L. Kurkin and N. S. Kurkina. "Avto. i Tel." July 1961. 7 pp. A transistor integrator circuit is suggested. The circuit is shown to correspond with properties of a transistor as an amplifying device more closely and therefore to use transistors better than Miller circuit. (U.S.S.R.)

**An Automatic Self-Checking Transistor Counter with Digital Display,** H. I. Messer and W.H.P. Leslie. "Elec. Eng." Aug. 1961. 6 pp. An automatic self-checking transistor counter with digital display and provision for a digital readout has been developed for normal laboratory use, and for use in data-logging systems. (England.)

**Highly Stable Terminal Stages of Transistor Low-Frequency Sweep Generators.** A. E. Model, V. V. Dranguinis. "Radiotek" 16, No. 7, 1961. 8 pp. The authors analyze the basic problems in the design of terminating stages of low-frequency sweep generators. (U.S.S.R.)

**Parallel Connection of Power Transistors in Pulse Operation.** F. W. Dietl. "El. Rund." July 1961. 1 pp. When several transistors are operated in parallel to switch large currents, the total current has to be uniformly distributed among all transistors. This is achieved with small emitter resistances. The author gives a simple dimensioning rule optimizing such resistances. (Germany.)

**Application of Transistors to Broadcast Programme Switching.** B. R. Perkins. "Proc. AIEE." May 1961. 7 pp. Experience has shown that switching of broadcast programs by conventional means, e.g., keys, relays or uniselectors, is not entirely satisfactory due to the variable "contact resistance" of these devices. An electronic switching circuit, using transistors, that overcomes many of these difficulties is described. (England.)

**Transistor-Resistor Logic.** A. D. Odell and S. J. Gardner. "Brit. C.&E." Aug. 1961. 6 pp. Economics of small data installations might be significantly altered if a logic system were available which gave appreciable reduction in cost even at some sacrifice in speed. From this standpoint transistor-logic (t.r.l.) appears particularly attractive, and this article discusses the design and performance of t.r.l. circuits. (England.)

**Semiconductor-Diode Waveguide Switch,** T. H. B. Baker. "El. Tech." Aug. 1961. 5 pp. The theory of operation of a wave guide switch is given, relating the switching ratio, bandwidth and power-handling capabilities to diode and transmission-line parameters. (England.)

**Common-Emitter Amplifier—Medium-Frequency Performance.** R. Leek. "El. Tech." Aug. 1961. 13 pp. The conditions are examined under which a simple equivalent circuit for a transistor may be applied with accuracy to an analysis of the common-emitter amplifier. (England.)

**An Analysis of Transistor Amplifiers with Uncompensated Feedback.** Y. G. Kryukoff. "radiotek" 16, No. 8, 1961. 9 pp. An analysis of tuned amplifiers is conducted on the basis of four-pole network theory. Formulae are obtained for the gain, input and output conductances, tuned frequency for maximum gain, pass band of the amplifier and its operating efficiency. Characteristics of the amplifier are evaluated for optimum matching. (U.S.S.R.)

**Industrial Applications of Zener Diodes.** H. Rotceig. "El. et Auto." March-April 1961. 4 pp. This paper describes a 0 to 30v, 0 to 5a, stabilised power supply and indicates its performance. It is shown how Zener diodes can be combined with electron tubes to make a constant-current source. (France.)

**Applications of Transistors in Medical Electronics,** J. Matisse. "El. et Auto." March-April 1961. 5 pp. This article describes typical applications of transistors in the field of cardiotachymetry, electrophysiology and measurement of blood pressure. (France.)

**Application of Semiconductors to Hearing Aid Design,** A. V. J. Martin. "El. et Auto." March-April 1961. 4 pp. It can be said that hearing aids reached the public domain with the advent of transistors. This paper describes four practical proven circuits of transistorized hearing aid amplifiers. (France.)

**Industrial Applications of Unijunction Transistors,** A. Kopf. "El. et Auto." March-April 1961. 7 pp. This article studies basic pulse generators and multivibrator circuits, and negative resistance bistable circuits. Practical applications are indicated. Variants of the circuits and waveforms produced are given. (France.)

**Semiconductor Diodes Are Used to Construct Symmetrical Non-Linear Resistance,** Tai Tse Hain. "Avto. i Tel." March 1961. 7 pp. The influence of the rectifier stability on the zero drift of the magnetic amplifier where even-harmonics are rectified with symmetrical non-linear resistance is considered. (U.S.S.R.)

**The Thermal Response of Transistors with a Non-Static Collector Dissipation,** H. Reimann. "Nach. Z." Feb. 1961. 4 pp. By means of an equivalent circuit an attempt is made to explain in a theoretical way the actual conditions in transistors. (Germany.)

**A Transistor Multivibrator,** B. Rakovich. "Elec. Eng." May 1961. 3 pp. An emitter-coupled free-running multivibrator is described. (England.)

**Application of the Four-Layer Diode,** W. Shockely & J. F. Gibbons. "El. et Auto." March-April 1961. 5 pp. This first part of the paper recalls the operation of the four-layer diode and studies the transient effect. Applications are described. The 2nd part of the paper will deal with bistable multivibrators, square wave generators, high efficiency and high reliability inverters. (France.)

**An Engineering Approach to the Design of Transistor Feedback Amplifiers,** E. M. Cherry. "Proc. AIEE." May 1961. 18 pp. A technique is developed for the design of transistor feedback amplifiers, based on the use of impedance mismatches between stages. (England.)

**Application of Semiconductors to Hearing Aid Design,** A. F. J. Martin. "El. et Auto." May 1961. 3 pp. This is the 2nd part of a paper. First part was published in Mar.-Apr. This article describes a few hearing aid designs: A simple amplifier using complementary transistors, a 3-stage amplifier with transformer coupling, a miniature direct coupled amplifier, and a 4-stage microminiature amplifier. (France.)

**Calculation of Two-Terminal Circuit with One Semiconductor Thermoresistance Operating as Linear System,** N. P. Udalov. March 1961. 4 pp. The calculation of two-terminal circuit with a semiconductor thermoresistance operating as a linear system is given. The calculation is applicable to circuits for temperature compensation and micro-thermostat. (U.S.S.R.)

**A Discussion on the Cut-Off Frequency of Tunnel-Diodes,** M. Muller. "Nach. Z." April 1961. 4 pp. The effect of the physical dimensions on the equivalent circuit parameters of Esaki-tunnel-diodes is determined or estimated. The combination of body and surface conductivity as it is found at very high frequencies is discussed in particular detail. (Germany.)

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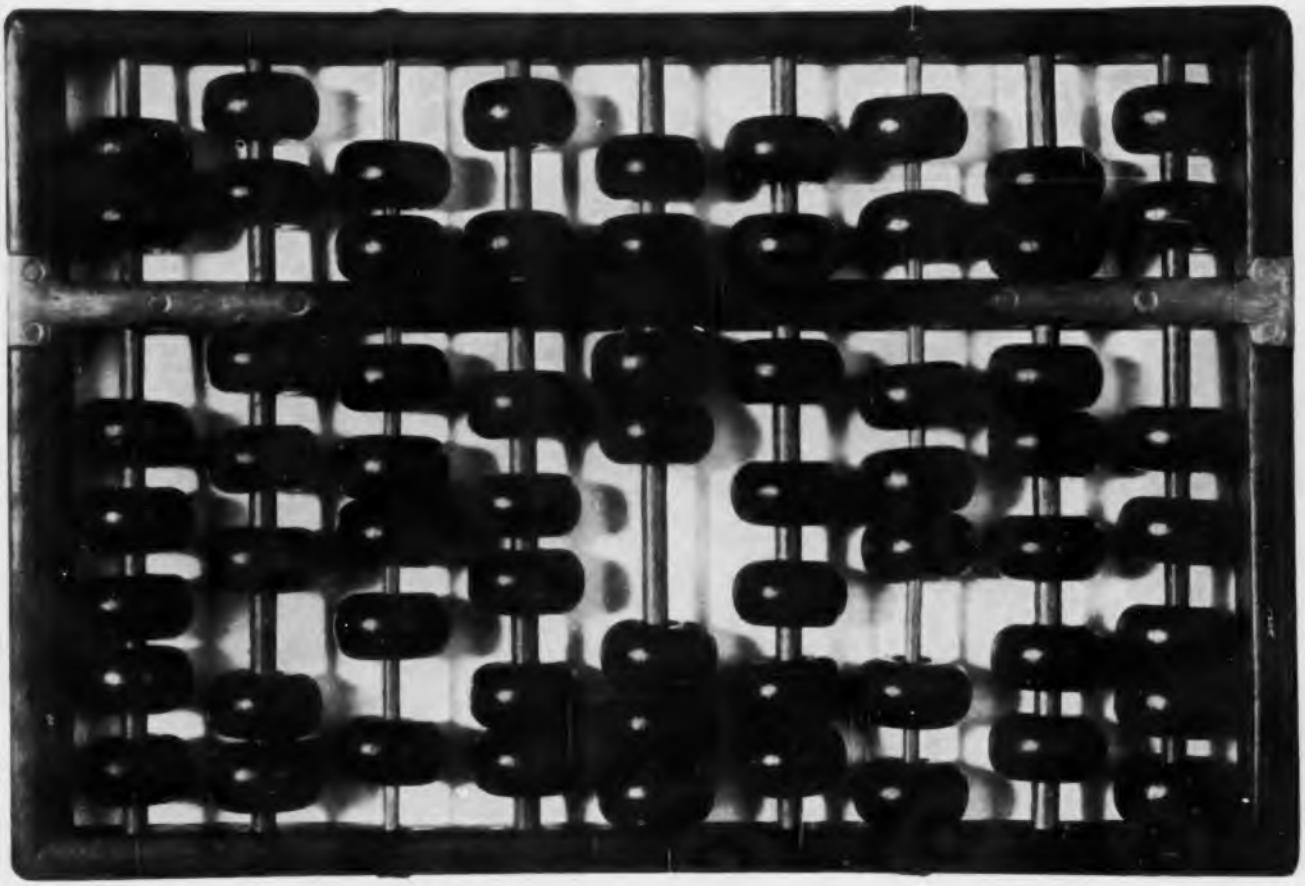

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# *International* ELECTRONIC SOURCES

**Parametric Amplifiers.** D. Gossel. "El. Rund." April 1961. 4 pp. The voltage-dependent capacitance of a semiconductor diode operated in reverse direction is explained with the aid of a p-n junction model. (Germany.)

**The Frigistor Diagram.** W. Dorr. "El. Rund." April 1961. 3 pp. A diagram has been plotted for the application of frigistors consisting of semiconductor devices. The diagram permits convenient dimensioning of cooling systems of this type. (Germany.)

## TELEVISION

**Simple Hum Compensation for TV Receivers.** H. Schat. "El. Rund." Aug. 1961. 3 pp. The paper shows that, in a power supply employing no choke, but a smoothing resistor, the fundamental wave across the charging capacitor lags by about 90° the mains voltage in the case of single-phase rectification. (England.)

**Lighting for Television Outside Broadcasts.** H. E. H. Mayhew. "Rundfunk." Aug. 1961. 9 pp. Because lighting is such an individual subject only the method of approach and the skeleton framework are indicated but this should prove more than interesting to all engaged in lighting for television. (Germany.)

**A High Power Klystron for Band IV TV-Transmitters.** W. Schmidt. "Nach. Z." Sept. 1961. 5 pp. The valve dealt with is a four-cavity klystron with an output of more than 10 kw for use in the output stages of band IV TV-transmitters. The external resonators are mounted on the outside of the ceramic-metal klystron. The beam is focussed by electromagnetic means. (Germany.)

**The Perceptibility of Non-Linear Distortions in Color-TV Pictures in the NTSC-System.** J. Muller and G. Weingenroth. "Nach. Z." Aug. 1961. 8 pp. The object of the paper is an investigation of the limits for the perceptibility of differential phase and amplitude fluctuations in NTSC color-TV pictures in order to obtain a guide for specifications for TV links in respect of these distortions. (Germany.)

**Conditions for Equal Picture Definition in Spiral Scanning and Line Scanning Systems.** K. V. Saprykin. "Radiotek" 16, No. 7, 1961. 6 pp. Relationships are derived to establish the relation between the number of lines in a line scanning television system and the number of loops in a spiral scanning television system which provide equal picture definition. (U.S.S.R.)

**The Conversion of an NTSC Color TV Signal into a Signal with a Different Chrominance Carrier.** H. Gorling. "Nach. Z." July 1961. 8 pp. The paper explains the purpose of the investigations and the test equipment. The design considerations for a converter are discussed. (Germany.)

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## THEORY

**Algorithmic Unsolvability of Problem of Recognition of Recursive Event Representability By Finite Automata.** M. A. Aizerman, L. A. Gusev, L. I. Rozonoer, I. M. Smirnova, A. A. Tal. "Avto. i Tel." June 1961 8 pp. An idea of recursive event formalizing the event effectively given by a word description is introduced. The problem of recognition of recursive events which are representable in a finite automaton is suggested and the theorem of its algorithmic unsolvability is proved. (U.S.S.R.)

**Investigation of Non-Stationary Processes in Pulse Systems with Stepping Motor.** V. M. Kolesnikov. "Avto. i Tel." July 1961. 11 pp. Main investigation problems for stepping systems with non-stationary oscillations are defined. Ways to solve the problems in question are suggested. (U.S.S.R.)

**The Determination of the Number of Sampling Points and the Approximation Function for Stationary Random Processes.** N. L. Sossensky. "Radiotek" 16, No. 8, 1961. 9 pp. An analysis of determining the number of sampling points, necessary for the approximation of a stationary random with a given accuracy, is solved on the basis of the theory of linear interpolation of stationary random processes. (U.S.S.R.)

**A New Standing Wave Indicator for Dielectric Surface Wave Lines.** G. Schulten. "Nach. Z." Sept. 1961. 4 pp. The theory of a new VSWR measuring line is reported and a practical design is described. (Germany.)

**Pontryagin's Maximum Principle and Optimum Programming of Rocket Thrust.** V. K. Isaev. "Avto. i Tel." Aug. 1961. 16 pp. The theory of optimum programming of a value and direction of a rocket thrust for cases of flat and space motion in homogeneous gravitation field without taking into consideration aerodynamic forces is exponded. (U.S.S.R.)

**Tables and Formulae for Determination of Accuracy Characteristics for Linear Stationary Dynamic System Operation.** A. N. Skliarevich. "Avto. i Tel." July 1961. 11 pp. Tables and formulae are given which simplify calculation of variance (as time function) and of output variable correlation function for a linear stationary dynamic system when a random process with a well-known correlation function is introduced to the system input. Some possible ways of determining limiting stable correlation function and stable variance are also described. (U.S.S.R.)

**Automatic Optimization of Space Distribution.** L. N. Fitzner. "Avto. i Tel." July 1961. 8 pp. For the extremal system considered in a way of designing a coordinate converter is described. Effect of lag elements, dry friction, backlashes and a dead zone on stability of a search process is evaluated. Some ideas on the effect of random noises are introduced. (U.S.S.R.)

**A Suggestion Concerning Uniform Symbols for Logical Functions.** W. Rekowski. "Nach. Z." July 1961. 6 pp. A series of symbols is recommended for the graphic representation of logical functions in Boolean algebra. It covers all logical functions with one or two variables and a practically important part of the logical functions with more than two variables. (Germany.)

**Calculation of Natural Resonant Frequencies of Complex Cavities Using Cylindrical Coordinates.** A. Y. Yashkin. "Radiotek" 16, No. 5, 1961. 12 pp. The author discusses a system of equations which serve to calculate natural resonant frequencies of a stepped cavity. Every complex cavity having one axis of symmetry can be reduced to such a stepped cavity. (U.S.S.R.)

**An Extreme Problem in the Theory of Amplifier Circuits.** N. N. Smirnoff, L. I. Filippoff. "Radiotek" 16, No. 2, 1961. 5 pp. A problem is considered to determine the optimum number of cascaded stages, N opt. for a narrow band amplifier, providing minimum instability of phase shifts introduced by the amplifier. (U.S.S.R.)

**Studies of Linear Systems on the Basis of the Fourier Series Apparatus.** A. M. Zayezdny. "Radiotek" 16, No. 2, 1961. 12 pp. It is shown that with the aid of a new method of finding periodic solutions to differential equations using tables of series sums in closed form, the Fourier series apparatus can be applied to the study of linear systems, acted upon by complex periodic disturbances, and allows to use simple means to calculate the response of the system. (U.S.S.R.)

**Theory of One-Core Magnetic Amplifier with Symmetric Non-Linear Resistance Rectifying Load Current.** Tai Tse Hsin. "Avto. i Tel." April 1961. 10 pp. It is shown that current in ac circuit has a constant component proportional to signal magnetizing direct current when symmetric non-linear resistance is switched in successively with a one-core reactor. (U.S.S.R.)

**Graphs for the Calculation of Double Tuned Bandpass Filters with Arbitrary Coupling.** Sittner and Minner. "Freq." March 1961. 7 pp. This paper contains diagrams for the calculation of double-tuned band-pass filters with the arbitrary coupling. The diagrams are obtained by modification and generalization of the well-known general calculation fundamentals. (Germany.)

**Theory and Design of a Monostable Pentode Multivibrator.** I. A. Zacharia. "Radiotek" 16, No. 4, 1961. 8 pp. A theoretical analysis is presented of a monostable pentode relaxation circuit using linear approximation for the tube characteristics. (U.S.S.R.)

**Application of Weibull's Law to the Prediction of Probable Lifetime of Electronic Equipment.** A. M. Gervaise. "Cab. & Trans." April 1961. 15 pp. In Miss A. M. Gervaise's paper, the properties and general character of this law are explained, emphasizing the reasons for its choice for such a purpose. (France.)

**Temperature Variation of Primary and Secondary Parameters of 2.6/9.5 mm Coaxial Pairs.** A. Payant. "Cab. & Trans." April 1961. 18 pp. The paper is a theoretical and experimental study of the variations of primary and secondary parameters of standard 2.6/9.5 mm coaxial pairs as functions of temperature and frequency. (France.)

**A Review of Methods of Linear Network Analysis in the Steady State.** P. W. Seymour. "Proc. AIRE." Feb. 1961. 21 pp. For constant or sinusoidal excitation of an electric network, this article reviews certain methods of analysis which permit determination of response in the steady state, reached when all transients have become negligibly small. (Australia.)

**A Magnetic Journal Bearing.** F. T. Backers. "Phil. Tech." #7, 1961. 7 pp. The article considers the theory of a shaft which is held in suspension by magnetic fields, and compares the theory with the results of measurements which have been made on magnetic bearings of various dimensions. (Netherlands, in English.)

**Wideband Amplifiers.** M. J. Kappen and S. Systra. "El. et Auto." July-Aug. 1961. 8 pp. This paper studies the general problem of wideband amplification and high frequency compensation by inductance. (France.)

**Bode's Variable Equalizer.** S. S. Hakim. "El. Tech." June 1961. 4 pp. Bode has described several types of variable equalizers in which the insertion-loss characteristic can be varied by the variation in the value of one of its elements. One such element can be a thermistor. In this article, the basic theory is developed for one particular type of Bode's variable equalizer that is most versatile. (England.)

**Transfer Characteristics of Periodically Gated Networks.** H. Kaden. "Freq." May 1961. 15 pp. Although according to the sampling theorem conditions can be so arranged that no information is lost, the received power is considerably attenuated as a rule as compared to the case of a permanently closed gate. With a trick circuit it is achieved, however, to eliminate this loss of power without recourse to amplification even in the case of very low on/off ratios, which is very important for switching applications. This paper furnishes an exact theory of this objective of giving instructions for proportioning all circuit elements so that attenuation and distortion factor are minimized. (Germany.)

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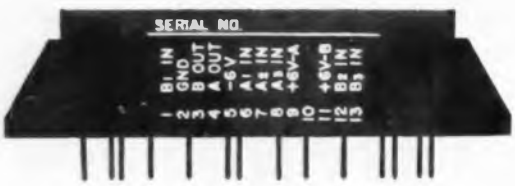


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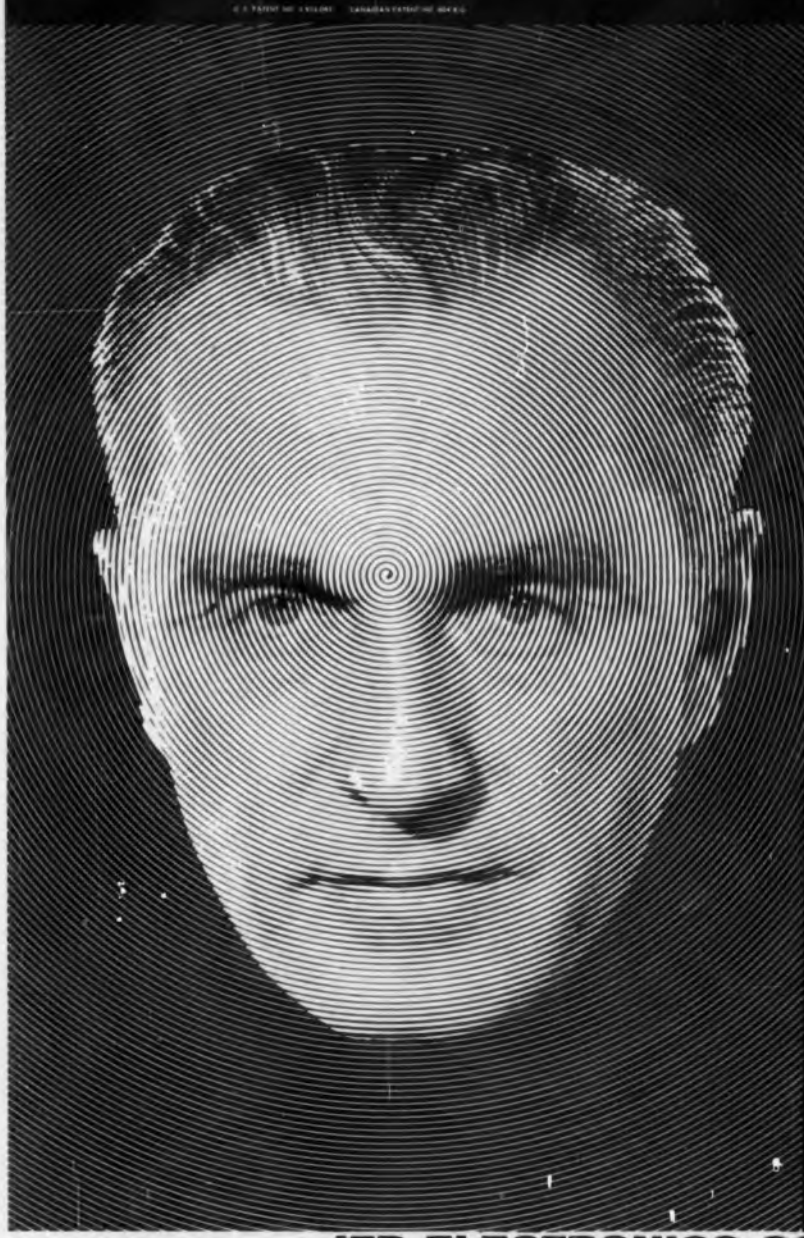

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0.6 to 6.0 pf section 1
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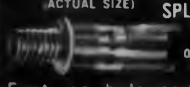

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MODEL SP8BG
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# ELECTRONIC OPERATIONS

The System Engineering Section of ELECTRONIC INDUSTRIES · DECEMBER 1961

## SYSTEMS—WISE . . .

### SATELLITE SCHEDULED FOR SPRING LAUNCH

Bell Telephone Laboratories technicians prepare a development model of a Bell System active communications satellite for special radio measurements. The 34 in. sphere will be used for experiments in the relaying of telephone calls, television signals and other communications overseas. Arrays of solar cells, used to convert sunlight into electricity, cover most of the surface. Microwave radio receiving and transmitting antennas form the belt around the middle of the satellite.

**▸ A new Radar Air Traffic Control Center Display system, producing a full 40 in. TV-type bright display, has been developed for the Navy Bureau of Ships by Lockheed Electronics Co. Designed as a universal instrument for use with medium and short-range search radars, the system displays trails on all moving targets. Up to 10 trails (or scans) can be stored at normal antenna rotational speeds for all targets simultaneously. The system requires only 3 signals from the radar: antenna rotation, radar sync and radar video data. The information is presented on a control-indicator display unit using a projection kinescope and a Schmidt optical system.**

▸ Southern Land Timber & Pulp Corp. has purchased a General Electric 312 process control computer for installation in its new, 700 ton/day kraft linerboard mill at Cedar Springs, Ga. The computer will be used for: logging approximately 450 pieces of process data from all areas of the mill; monitoring to provide close surveillance of process variables for off-normal conditions; and providing output control for selected mill processes. Conventional instruments and control systems will be used to perform most real-time functions to free the computer as much as possible for multi-variable information processing. The G-E 312 is a fully transistorized, stored program digital computer, with a rotating magnetic drum memory capacity of 54,000 words.

**▸ Negotiations have been completed by Alpha Corp., Div. of Collins Radio Co., Dallas, Tex., and Mid-Valley Pipeline Co., Longview, Tex., for a new microwave system extending from the pipeline's main office in Longview to Lima, Ohio. The 1,000 mile system extending along Mid-Valley's main right-of-way will include a total of 43 microwave stations. The program will be completed during mid 1962.**

▸ Radio Corp. of America, under a $16.4 million contract awarded by the International Cooperation Administration (ICA), is building a 3,060 mile telecommunications network linking Turkey, Iran and Pakistan. The network will extend from Ankara, Turkey, as the westernmost terminus, to Teheran, and thence to Karachi. Officially known as CENTO Telecommunications Network, the microwave radio equipment will be able to handle up to 600 telephone voice channels. Heart of the system will be the RCA Victor MM-600 Radio Relay Equipment. In all, approximately 92 radio relay stations will be erected, some at altitudes of more than 10,000 ft. The contract calls for the completion of the project within 30 months.

**▸ The Remington Rand Univac division of Sperry Rand Corp., Military Dept., St. Paul, Minn., has announced that it has a 166,000 binary digit thin-film memory, production item for use with miniaturized electronic computers. The 166,000 binary digits are provided in a space of about one-third cubic ft. including associated circuits. All words stored in the memory, except 256 of them are available for use with an associated computer on "non-destructive read-out" basis. Switching time in this memory is in the nanosecond range.**

▸ Dynatronics, Inc., Orlando, Fla., has installed for the USAF a new digital data system at the Air Force Flight Test Center, Edward AFB, Calif., for the collection and display of aerospace vehicle test data. The system will be used in such development programs as the B-70 and with modifications will accommodate data formats on programs such as the Dyna-Soar.

### FREE WORLD'S LONGEST "TROPO" LINKS

Huge, 120 ft. antennas at Nikolski in the Aleutians form one of the stations in the communications network which links Anchorage, Alaska, with Shemya at the western tip of the Aleutian Islands. Included in the new communications route are two of the longest "tropo" links in use. These are the 341 mile segment between Nikolski and Adak and a 395 mile segment between Adak and Shemya. The "tropospheric scatter" radio relay network was engineered, installed and tested by the Western Electric Co., for the U.S. Air Force.


**By S. P. FAIRCHILD, Jr.**
*District Electronic Engineer*
*Federal Aviation Agency*
*Tallahassee, Fla.*

# Telephone Cable

THE use of audio tones for remote control functions has come into widespread use. A simplified block diagram of such a system is illustrated in Fig. 1. Since the control site and the controlled functions are sometimes hundreds of miles apart, the limiting factor of such a system is usually the control line itself.

In order to effectively use the tone control system, the communications engineer should know the following facts about the control line:

1. Input impedance at the sending end.
2. System balance to ground.
3. Overall frequency response.
4. Noise characteristics.
5. Output impedance at the receiving end.

### *Sending End Impedance*

The sending end impedance must be determined for two reasons:

1. The sending tone power level cannot be accurately determined unless impedance is known. Standard telephone practice dictates that a known power level must be fed to the line instead of a voltage level.
2. Line impedance must be known so that it can be matched to the output impedance of the tone senders. This can be done with a multi-tap line matching transformer, called a repeat coil. Cables loaded for good frequency response will vary widely in impedance from one installation to the other, often in the range of 300 to 2500 ohms. Another problem encountered is the change of line impedance with frequency. This is due to the loading of the cable by the serving company and is expressed by the formula

$$Z_o = \sqrt{L/C - \frac{\omega^2 L^2}{4}}$$

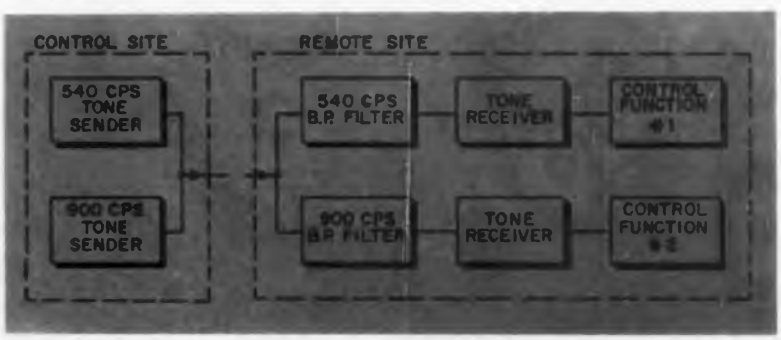
where $L$ is the inductance of each loading coil plus that of the intervening line in henrys, $C$ is the cable capacity between load coils in farads and $\omega$ is $2\pi f$. Thus it can be seen that $Z_o$ usually decreases as frequency is increased. Final adjustments of equipments using this type of line are usually a compromise based on the impedance found at the center of the audio bandpass being used.

### *Measurement of Input Impedance*

If absolute maximum power transfer from tone senders to the line is desired, accurate measurement of both $R$ and $jX$ factors of the line is necessary with an impedance bridge or other laboratory type equipment. This is due to the theorem that says *maximum power will be absorbed by one network from another joined to it at two terminals, when the impedance of the receiving network is varied, if the impedances looking into the two networks at the junctions are conjugates of each other.*

In most practical applications, it is not feasible to match impedances by the conjugate method. In addition this method has the disadvantage of providing an exact impedance match *at one frequency only.* Therefore, we can take advantage of a second theorem that states *if*

Fig. 1: Block diagram of a simplified control system.



*Audio tones are being widely used for remote control functions. Telephone cables are often used as the tone carrying medium. For optimum results, several cable parameters must be known. These parameters and the methods of determining them are described.*

# Measurement Techniques

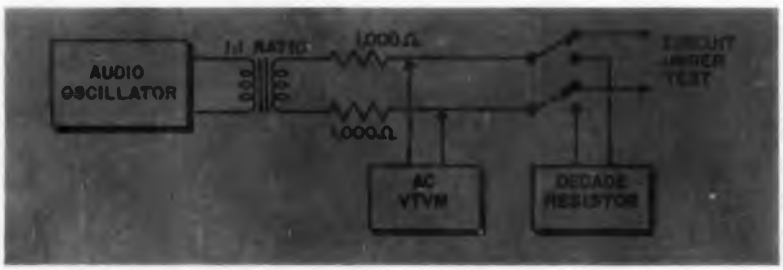



Fig. 2: Method of measuring the magnitude of unknown control line impedance.

*the magnitude of the load impedance may be varied, but not the angle, then the maximum power will be absorbed from a generator when the magnitude of the load impedance is equal to the magnitude of the impedance of the supply network.*

The use of the impedance matching method suggested by the second theorem is quite adequate for tone control work and simplifies greatly the task of measuring cable input impedance.

A simple hookup for measuring line impedance magnitude is illustrated in Fig. 2. The decade resistor is adjusted to give the same voltage reading as is obtained across the circuit under test. The 1/1 ratio transformer is necessary with audio oscillators having an unbalanced output.

### *Balance to Ground*

Control lines run over great distances are invariably the "balanced-to-ground" type. This means that both sides of the line should have equal shunt admittances to ground and equal series impedances. Use of such a line insures that unwanted noise and hum voltage induced into it, from outside sources, will arrive at the two receiving terminals with equal amplitudes and opposite phase, and thus be cancelled at the input of the receiving equipment.

Partial or complete short of one side of the line to ground will cause excessive noise and hum to enter the tone control equipment, causing failure or faulty operation.

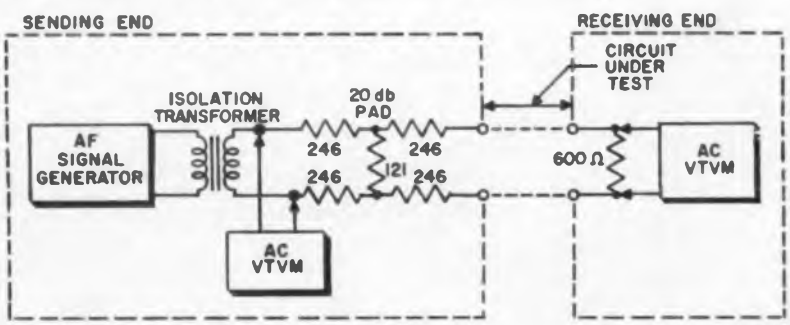
Equality of resistance measurements to ground may be made with an ohmmeter, and equality of capacities to ground may be made with a capacity bridge. Any unbalance in the line itself, of course, can be corrected by the serving company only. Any unbalance in the equipment connected to the line is corrected by the user. Unbalanced equipment can be connected to the line by the use of a 1/1 isolation transformer.

### *Overall Frequency Response*

The number of tone control functions used is necessarily limited by the bandwidth of the control line.

*(Continued on following page)*

Fig. 3: Measurement hook-up for measuring the control line audio response.



# Cable Measurements *(Continued)*

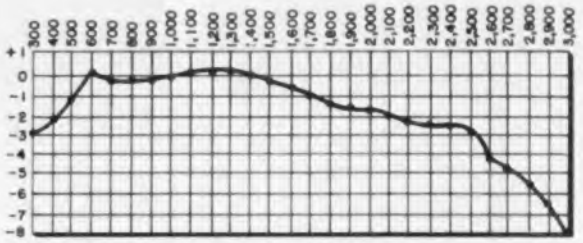



Fig. 4: A typical response curve for an upgraded telephone line.

When more functions are desired than an ordinary telephone line can provide, it may be re-engineered or upgraded at higher cost to the user. At any rate, the frequency response of the line must be periodically checked to see if its response is adequate for the tone control system is use.

A typical audio response hookup is shown in Fig. 3. The use of the 600 ohm to 600 ohm 20 db pad between the audio oscillator and the input of the control line accomplishes three things:

1. It allows the use of a higher output from the audio oscillator in the more stable and easily measured portion of its range.
2. The ac VTVM can be read directly in dbm if it is so calibrated for 600 ohms. This is because the input of the pad remains essentially 600 ohms regardless of variations of the loads across its output.
3. The power level introduced into the line will be fairly constant with wide variations of line impedance.

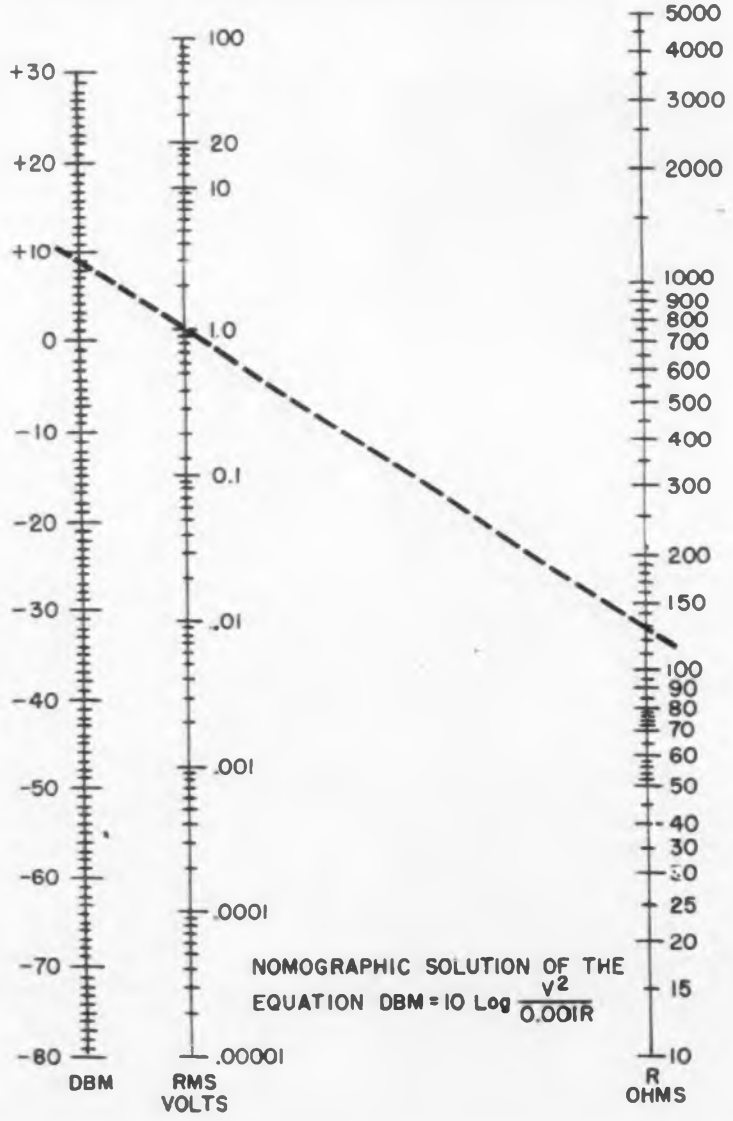
One interesting sidelight of this hookup is the impedance matching characteristics of the 20 db pad. If an impedance matching transformer had been used, wide variations of the secondary load impedance would be reflected to the primary and thus cause the dbm readings to be invalid. The use of the pad, however, not only matches the generator to the load at the nominal impedance of 600 ohms, but maintains a good match at any load impedance in the 300-2500 ohm range. Therefore, it maintains its attenuation characteristics near 20 db over a wide range of load impedance values.

The choice of a 600 resistive load at the receive end is mainly to facilitate the reading of the ac VTVM directly in dbm. (O dbm equals one milliwatt.) Thus, with accurate power level measurements being made in dbm both at the input and the output of the line, accurate line attenuation in db can be determined. After measurements of frequencies in the audio bandpass, a frequency response curve can then be plotted. A typical response curve for an upgraded telephone line is illustrated in Fig. 4.

In the more complex tone control systems, tones are sent both ways. (On diagrams of these systems the site on the left is usually labeled "west" and the one on the right "east." Signalling is then referred to as "east-to-west" or "west-to-east.") In this case, two response measurements are needed; one "east-to-west" and one "west-to-east."

In making the response measurement, an audio tone is sent on the line at a level low enough to prevent cross-talk, usually −8 dbm. If the received level at 1000 CPS was, say, −17 dbm, this is entered on the chart (See Fig. 4) on the "O" line

Fig. 5: Nomograph for determining the dbm from voltage measurements.



and all other levels referred to it. Thus if 2100 CPS were received at −19 dbm it would be entered on the "−2" line, etc. The overall response can then be compared to predetermined specifications.

### *Line Noise*

All lines will have unwanted noise to some degree. Excessive noise will, of course, reduce the signal-to-noise ratio and cause system instability. In addition it will prevent the measurement of accurate audio response readings.

Noise outside the bandpass of the receiving equipment usually is no problem to equipment performance, since it is rejected in the bandpass of the input of the equipment itself. The presence of this "out-of-band" noise, however, will interfere with normal noise measurements if a wide bandpass ac VTVM is used. To use an example: An engineer is measuring noise on a control line to use with 300-3000 CPS bandwidth equipment. If he uses an ac VTVM with a bandpass flat to 4 MC, noise or other signals in the 3500 CPS to 4 MC region might interfere with his noise readings, even though it is of no concern to equipment operation. In this case a weighting filter should be inserted between the control line and the VTVM (at the receiving end) so as to accurately indicate the true signal to noise ratio in the band in which he is interested. The type 11-B ac VTVM manufactured by Consolidated Electrodynamics Corp., Pasadena, Calif., incorporates such a filter that can be switched in and out for noise measurements. It uses an FIA weighting filter that passes only noise that can be heard in the FIA telephone receiver. (500-2000 CPS.)

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of this article can be obtained by writing on company letterhead to
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ELECTRONIC INDUSTRIES
Chestnut & 56th Sts., Phila. 39, Pa.

### *Output Impedance*

On telephone cable of great length, the $Z_o$ at the receiving end will not necessarily be equal to the $Z_o$ at the send end. Therefore, it is necessary to make this measure-

(*Continued on Page* 214)

## Cable Measurements
*(Concluded)*

ment to accomplish impedance matching with the receiving equipment. In addition to proper power transfer, proper impedance matching at the receive end insures a low VSWR on the telephone line, which leads to greater day to day stability of tone levels.

**References**


W. L. Everitt and G. E. Anner, *Communication Engineering*, Third Edition, McGraw-Hill Book Co.

C. I. Carpenter, *A Better Understanding of our Peripheral Communications Circuits*, Federal Aviation Agency, February 1960.

*Operation and Maintenance Manual, 11-B Voltmeter*, Consolidated Electrodynamics Corporation, Pasadena, California.


## Function Generator


*(Continued from page 132)*


pulse pattern may be either in pulse or step form from 6 to 10 v positive going with a maximum rise time of 0.6 μsec. Input impedance is 5000 ohms.

Output signals are 1 μsec pulses standardized at 6 v into 6000 ohms.

Operating power required is 250 ma of —18 vdc, 250 ma of —6 vdc and 50 ma of + 12 vdc.

Units are designed to operate at temperatures up to 55° C. Temperature coefficient of delay is approximately 10 parts per million degree Centigrade temperature change.

The entire system is contained in an enclosure measuring 12 in. x 12 in. x 3 in., and weighing 5 lbs.

### OPTICAL READER

**John Schlegel, Pennsylvania Power & Light Company computer operator, watches the IBM 1418 optical character reader as it reads numerical information from 400 documents a minute. First optical scanner to read conventional printed or typed information directly into a computer has been installed in PP&L Co's new computer center.**

# "Project Beacon"—
## Air Safety Through Electronics

Air safety has been given a big electronic boost, to the tune of $500 million, with President Kennedy's acceptance and endorsement of the Project Beacon Report on air traffic control.

In a letter, dated Nov. 7, 1961, to N. E. Halaby, FAA Administrator, the President gave the go-ahead to providing more safety in our congested airlanes, "I ask you to begin at once to carry out those recommendations of the report which you believe will move the airways program forward rapidly and efficiently."

Although money is one of the major concerns affecting our air safety program. Project Beacon recommended an increase to $500 million over the five-year period to put the proposed system into working order. FAA plans had previously called for only $250 million.

Commonly called the "Hough Report," after Richard R. Hough, Vice President, Engineering, American Telephone and Telegraph Co., Head of the Project Beacon Task Force, the report emphasized the major part to be played by electronics in untangling the airways maze.

To cope with the increasing number of domestic aircraft in the air —now averaging 2,400 per hour and expected to exceed 3,600 per hour by 1975—50% more will be spent on radar and computers.

The proposed life-saving system consists of: an automatic digital computer (off-the-shelf type); radar with a highly accurate range of 100 miles; aneroid altimeter transponders to be installed in the aircraft; radar displays containing radar video and beacon signals, an extrapolated flight plan and in alphanumeric symbols the identification and altitude of aircraft; and some type of monitoring device (light gun or joy stick) for use by the air traffic controller.

The computer would do all the ordinary book-keeping, acting as an aid to, but not taking over the duties of air traffic controllers.

Some of the duties to be assumed by computers are: to be used for both en route and terminal control operations to process flight plans, issue clearances, investigate conflicts, produce display information, establish landing sequences and perform other routine control tasks. These computers would be less elaborate than systems formerly under development.

No 3-D radar or height finder now available or under development appears to meet FAA requirements of performance and reliability.

Small, relatively inexpensive ($500.00) sealed altitude encoded beacon transponders were recommended for installation in aircraft over 12,500 pounds, for obtaining automatic altitude information. The report further stated that ground-to-air automatic communication equipment, now available, is both too expensive and heavy for widespread use.

The report also emphasized that the recommended system was only the initial framework on which final development of the necessary displays and input/output devices could be based. It is felt that the prototype system will be ready for testing 18 months after development is initiated.

At the present time the FAA has in its possession two systems approximating FAA requirements, one of which is currently under test at the Atlantic City Test Facility.

Some future systems requirements include: a system based on continuously available 3-D position information on controlled aircraft and using general purpose computers; economically feasible, efficient and accurate air-ground communications systems; and an integrated all-weather landing system for both automatic and manual use.

With regard to the last requirement, it is said the FAA now has such a system available. What the considerations are affecting this system's incorporation into FAA plans are not yet known.

# Personals

**Dr. Charles E. Enderby**—appointed Senior Engineer, Advanced Fast-Wave Electronic Devices, Traveling-Wave Tube Products Section, General Electric Co., Palo Alto, Calif.

Shockley Transistor, unit of Clevite Transistor, Palo Alto, Calif., announces the following appointments: **R. L. Biesele, Jr.**—appointed Manager of Operations; and **Joseph M. Welty**—named Chief Engineer.

**Raymond W. Meyer**—named Director of Quality Assurance, Eitel-McCullough, Inc., San Carlos, Calif.

**Rolf D. Weglein**—appointed Head of Product Development, Microwave Tube Div., Hughes Aircraft Co., Los Angeles, Calif.

R. D. Weglein

C. H. Knowles

**C. Harry Knowles**—named Assistant General Manager for Research and Advanced Development, Motorola's Semiconductor Products, Inc., Phoenix, Ariz.

**Paul Gallagher**—has joined Rheem Semiconductor Corp., Mountain View, Calif., as Section Head, Reproduction Engineering.

**J. W. von Brimer**—has joined Transco Products, Inc., Los Angeles, Calif., as a Research and Development Engineer.

**Stuart R. Hennies**—named Chief Engineer, E-H Research Laboratories, Inc., Oakland, Calif.

**W. J. Busteed**—appointed Director of Quality Control, Instrument Div., Bourns, Inc., Riverside, Calif.

**Frederick C. Hawkes** — appointed Chief Scientist for SPECTRAN Electronics Corp., Maynard, Mass.

Varian Associates' Instrument Div., Palo Alto, Calif., announces the following appointments: **Dr. Harry E. Weaver**—named Manager of Optical Pumping and Cryogenic's Research; and **Dr. James T. Arnold**—appointed Manager of Research in Geophysics and Space Physics.

# CUES for Broadcasters

## Mounting a Gates Audio Console

*RICHARD E. LEE*

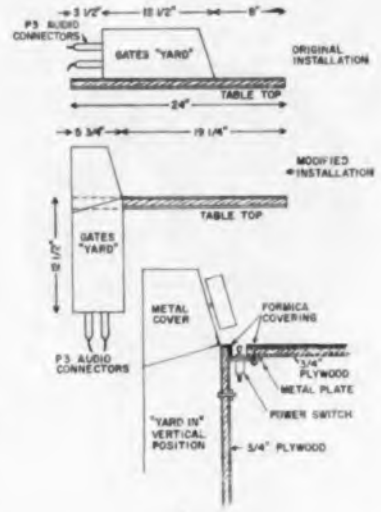
*KCBY-TV, Coos Bay, Ore.*

At first glance the Gates "Yard" series of audio consoles appear to be ideal units for use in a compact control room or for use on remotes. However, while the unit is of reasonable length (36 in.) and only 4½ in. high, the depth is out of proportion to the other dimensions, especially when used with P3 connectors, which connect on the back and extend the console depth to approximately 15 in.

The initial standard installation (as shown in the first diagram) left too little elbow room. Rather than build a larger desk which could not be moved easily, the console was remounted in an unconventional, but extremely effective way (as shown in the second diagram).

It only requires cutting a notch in the table top and building a simple sheet metal cover for the console. No dimensions are given for the cover since they will vary depending on what angle is desired for the console panel, with respect to the table top. The front panel is already hinged at the bottom and will fold down far enough to allow setting at any angle between 0 and 90°. The top, which is also hinged, became the back and folds down for tube replacement and maintenance. The back, where the connectors are, became the bottom and the cables are underneath and out of sight.

As an added convenience the notch (as shown in the diagram) was cut 8 in. deep and a mounting plate for turntable and tape machine power switches were included. The switches are low enough so that they do not extend above the table top and are not easily turned-on accidentally. The switch and attenuator controlling the same unit are in line to allow one-handed operation.




Dimensions and construction details are shown for re-positioning the audio console to obtain more table space.

The table used in this installation is 24 in. wide and 7 ft long with a Gates C-200 series transcription turntable at either end. A pair of tape machines in a 4 ft cabinet at the announcer's left, and another pair of transcription turntables in individual cabinets at his right, make up the complete control room.

## A Parabolic Mike System

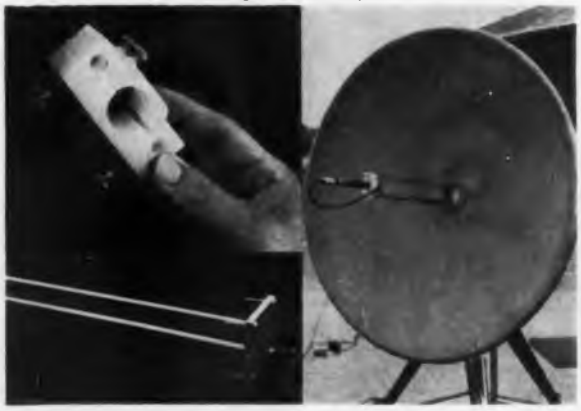
*T. A. BONE, JR., Asst. Chg. Eng.*

*WTVD, Durham, N. C.*

Television broadcasters, who have only an occasional need for a parabolic microphone system, may find the following idea useful and inexpensive.

A Raytheon KTR-1000, or KTR, portable microwave system (which has 4 parabolic reflectors, two 2-ft dishes, and two 4-ft dishes) can be modified by using one of the 4-ft dishes, and without altering the microwave antenna system, dish "L" bracket, or feed horn in any way.

Upper left shows the mike bracket and lower left is the waveguide blank and rods. Right is the complete unit assembled.



The first step is to make a mounting plate blank the same size as that found on the rear of the waveguide. To this plate, attach two stainless rods, ⅜ x 24 in., by drilling holes in the outer-most edge, but keeping them close enough together to allow passage through the center hole in the dish. Secure the rods with 6-32 set screws. Place the rods in the same position in the dish as the waveguide was located.

The mounting bracket or support for the microphone may be machined conveniently from a block of nylon, 5 x 2 x 2 in. An Electro-Voice 655-C, or any similarly shaped stick-type microphone will work well. The 655-C requires a mounting hole in the nylon block approximately 1 in. in diameter. On both sides of this 1-in. hole, drill a ⅜-in. hole for the stainless support rods. Add thumb screws to lock the block at the proper focal point along the rods.

Mount the dish, support, and mike to the "L" bracket and attach the complete system to the tripod. (Obviously, the RF head is omitted.)

An additional convenience could be added to this system by bridging the mike line with a transistorized amplifier. This could be used by the operator to follow a marching band or similar moving target.

# Personals

**Dr. Elizabeth B. See**—named a Senior Scientist in the Research Dept., Acoustics Associates, Inc., Los Angeles, Calif.

**Dr. Norris Johnston** — appointed Consultant to the Engineering Dept., Oak Mfg. Co., Crystal Lake, Ill.

Transitron Electronic Corp., Wakefield, Mass., announces the following appointments: **Dr. H. Gunther Rudenberg**—named Director of Corporate Research and Development; and **Dr. David C. Navon**—appointed Director of Semiconductor Research and Development.

**Harold L. Flowers**—named General Manager of Engineering, Electronics Operation, Avco's Electronics and Ordnance Div., Cincinnati, Ohio.

H. L. Flowers

R. Peth

**Robert Peth**—promoted to Manager of Engineering, Mobile and Portable Communications Products, Motorola's Communications and Industrial Electronics Div., Chicago, Ill.

**Dr. George Wertwijn** — appointed Director of Device Development, Rectifier-Capacitor Div., Fansteel Metallurgical Corp., No. Chicago, Ill.

**William P. Schneider**—named Manager of Engineering, Electrodynamic Instrument Corp., Houston, Tex.

**Robert J. Papaieck**—named Senior Electronic Engineer, Systems Engineering Dept., Frequency Engineering Laboratories (formerly Frequency Standards), Asbury Park, N. J.

**Bernard J. Weiss** — named Engineering Manager, Microwave and Production Equipment Dept., Raytheon Co., Waltham, Mass.

**David R. Vreeland** — appointed Plant Manager of Allied Control Co., Inc.'s, Plantsville, Conn., facilities.

**Robert L. Rudolph**—named Assistant Chief Engineer, Synthane Corp., Oaks, Pa.

# WASHINGTON News Letter

**PUSH FOR ALL-CHANNEL SETS**—At the next session of Congress the FCC will renew its proposal for legislation to enable it to advocate, through regulation, the manufacture and distribution of all-channel television sets. This legislation is now before Congress in Senate and House bills which were introduced in the last session. Electronic Industries Association's consumer products member companies are now considering the proposal that all TV should move to the UHF portion of the spectrum.

**ALLOCATIONS POLICY DELAYED**—Deadline for comments on the overall allocations policy proposals has been extended from Dec. 4 to Feb. 4. The FCC, while not specifically announcing the reasons for the extension, had three major explanations for the action. They were that overall policy proposals are much more complex and need more time; de-intermixture of TV allocations can be made without disturbing the policy proceedings; and the FCC will be called to testify before Congress on allocations. The FCC in its determination for the future spectrum place for television is desirous of getting definite results from its New York (Channel 31) UHF-TV station measurements and tests. Up to date the UHF tests have been reported as "very promising" with good signal coverage.

**SPACE ROADBLOCKS**—Despite President Kennedy's policy pronouncement to implement steadily, through the private communications industry, financing and operation of communications space satellites, segments of his Administration, notably the Justice Department's antitrust division, are continuing to establish roadblocks in the path of the communications industry's plans for implementation of satellite communications. This position was reiterated recently by the Assistant Attorney General in charge of the antitrust division when the Senate Small Business Committee held hearings on the program of the communications industry "ad hoc" committee for the implementation of communications satellites. The FCC which created the "ad hoc" committee countered with emphatic views that it had the regulatory responsibility for the industry's launching of communications satellites and determination of the industry committee's approach.

**UNION SUPPORT**—The principal labor organization in the communications industry, the Communications Workers of America, through its president, Joseph A. Beirne, has given strong and unequivocal support to the position that private enterprise, the communications industry, be given the task of operating a satellite communications system. Mr. Beirne has sharply criticized the delays of the Congressional hearings with the statement that the United States could have put into operation a space communications system this year if there had not been the Congressional debate about the system's ownership. Mr. Beirne pointed out that the FCC regulatory powers are adequate to protect the American public.

**MOBILE RADIO IMPETUS**—To aid the frequency "famine" of non-broadcast services, FCC Commissioner Robert E. Lee has proposed the utilization of the approximately 50 unassigned VHF television channels, plus the channels in 8 TV markets designated to de-intermixture, to provide additional new frequencies for mobile radio services. This would make some 2,000 frequencies immediately available for non-broadcast use. The proposed new channels for mobile radio would consist of a one megacycle band taken from the center of each television channel band with each megacycle further divided into 34 separate frequencies for non-broadcast use.

*National Press Building* *ROLAND C. DAVIES*
*Washington 4*

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**DEMAND FOR ENGINEERS** and scientists was expected to swing upwards in July and August but failed to materialize. The predictions were based on a sharp rise in engineer demand in June.

**NATIONAL ASSOCIATION OF BROADCASTERS** has asked the FCC to temporarily suspend the issuance of construction permits for FM facilities that would conflict with mileage separations in the FCC's proposed revision of FM broadcast rules.

The FCC proposal, among other things, would limit the distances between existing FM stations and any new facilities which would operate on the same or adjacent frequencies.

"Accordingly," it said, "the Association believes that until the Commission's proposal with respect to FM allocations is finalized, it is appropriate to suspend the processing of all applications which conflict with the Commission's tentative conclusions with respect to mileage separation for co-channel and adjacent channel spacing. . . .

The Association believes that this suspension policy is necessary to insure that new assignments are not allowed to prejudice the Commission's proposed long-range constructive action with respect to FM allocations."

The NAB said that applications for new FM facilities which are not in conflict with the proposed separation rules should be acted upon as usual.

# C NEWS

## New Markers Designed Expressly for Electronic Wire Identification

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(AE) Special — W. H. Brady Co., Milwaukee, announces the first off-the-shelf self-sticking Wire Marker made especially for marking wires in electronic equipment, assemblies, harnesses and cables.

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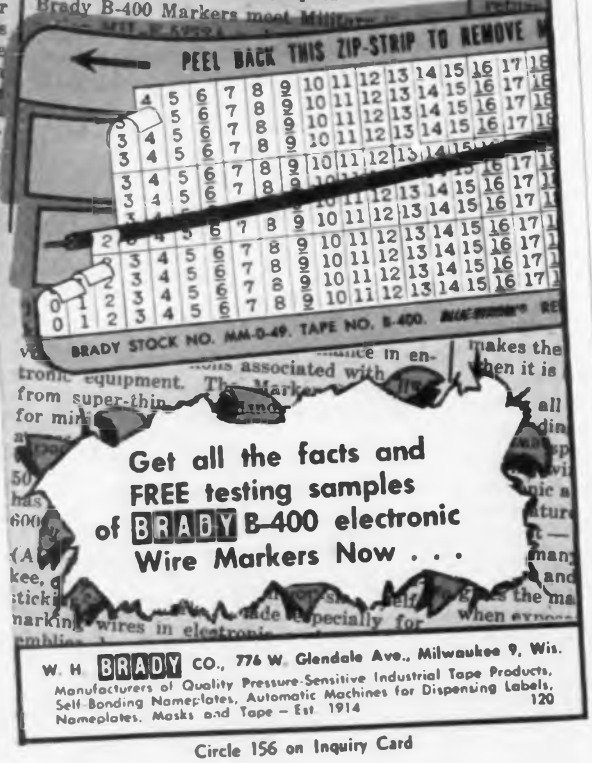
**Outstanding Performance Characteristics**

The physical properties of Brady B-400 Markers assure superior performance in environmental conditions associated with electronic equipment. The Markers are made from super-thin reinforced plastic material for minimum bulk. They withstand temperatures to 350° F; resist commercial solvents, oil, dirt and weather. Unaffected by 50 hours ultraviolet exposure. The material has an average dielectric strength of 6000 volts.

**Meet Military Specs**

Brady B-400 Markers meet Milit

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Circle 156 on Inquiry Card

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Circle 157 on Inquiry Card

# PROFESSIONAL OPPORTUNITIES

Reporting late developments affecting the employment picture in the Electronic Industries

**Design Engineers · Development Engineers · Administrative Engineers · Engineering Writers**
**Physicists · Mathematicians · Electronic Instructors · Field Engineers · Production Engineers**

## *Radio Amateur Award Call For Nominations*

A call for nominations for the tenth annual Edison Radio Amateur Award for outstanding public service has been issued by L. Berkley Davis, chairman.

"The 1961 Edison Radio Amateur Award will mark the tenth anniversary of this program," it was pointed out by Mr. Davis, vice-president in charge of the G. E. Company's Electronic Components Div., sponsor of the award.

Nominations of radio amateurs who have performed public services in 1961 must be post-marked no later than Jan. 3, 1962, and addressed to Secretary, Edison Radio Amateur Award Council, G. E. Co., Owensboro, Ky. Complete details of public services performed should be included to facilitate judging. A "Guide for Preparing Nominations" will be sent to those requesting it.

Candidates must hold valid amateur radio licenses issued by the FCC and must have performed the public service cited while in pursuit of their hobby.

## *Dr. Weiss Awarded Industry Scholarship*

The CompuDyne Foundation in Industry Scholarship has been awarded to Dr. Gerald Weiss, assistant professor of Electrical Engineering at Polytechnic Institute of Brooklyn. Selection of Dr. Weiss for the $1,000 award was made by the Foundation for Instrumentation, Education and Research, Inc., a non-profit organization dedicated to the advancement of instrumentation, education and research. In addition to the award, Dr. Weiss spent a four-week period at CompuDyne Corp., Hatboro, Pa., studying the application of the most recent theory in instrumentation and automatic control and at the same time gaining practical experience on high performance electromechanical hydraulic servo mechanisms. This is part of the FIER program in bringing education and advance laboratory research people together with industry.

## Engineers Asked to Help Break Down Bugaboos in Professional Societies

Arthur B. Bronwell, Worcester Polytechnic Institute president, in a speech prepared for delivery before the Engineers Council for Professional Development at the University of Louisville, Ky., asked some of the nation's top engineers to help "break down the firmly entrenched bugaboos against philosophical, speculative thinking in our professional societies."

He said that there is a prodigious amount of "hole-plugging" research, the piecing out of voids in existing well-defined structures of knowledge. He stated that civilization's great triumphs have never been patchwork jobs and asked for a place where talented young people can thrill to the visions of the future as expounded by the great minds of the present.

"This is the exciting area," he said, "where youth will capture bold new ideas and run all the way, outdistancing even prophecy. It is always in the embryo stages of new ideas where inordinate delays occur. At this stage, nothing is certain, and it is here where philosophical discussions that illuminate the future are of utmost importance in moving ideas into the take-off stage."

He continued, "Curiously enough, we know very little about the logistics of ideas. We are far more concerned with the logistics of traffic flow, of corporate inventories, or production schedules, than about ideas."

"Our methods today are haphazard, archaic, and obsolete. The problem is so universal and it so vitally affects our pace of progress, that the logistics of ideas and the kinds of institutions in which worthwhile ideas can germinate and move into the mainstream of human experience will in itself emerge as an exciting new field of exploration."

**RESEARCH AWARD**

Dr. J. A. Van Allen, (r) pioneer in cosmic ray research, receives first annual American Society Research Award from D. W. Douglas Jr., president of the Douglas Aircraft Co., which will donate the award annually through the ARS to an engineer or scientist conducting outstanding individual research in the field. Award includes a medal, citation and a $2,500 honorarium.

## *NAIC Award To Bourns*

National Association of Investment Clubs has announced that Bourns, Inc., Riverside, Calif., electronics manufacturer, has been voted the Growth Company of 1961 by the NAIC. NAIC includes 6,700 clubs throughout the U. S. with total membership of over 92,000.

**FOR MORE INFORMATION . . . on positions described in this section fill out the coonvenient inquiry card, page 205.**

*In response to our editorial request in our May 1961 Issue, we received a considerable number of technical data filing suggestions from our readers. Here is the first article of a new series on this subject. We hope this series will assist our engineering readers in keeping track of their technical reading.*

# Cataloging Technical Articles

**By STEVE C. GIOIA**

*Electronic Engineer*
*The Emerson Electric Manufacturing Co.*
*8100 Florissant Ave.*
*St. Louis 36, Mo.*

**First of a Series**

WITH all the technical articles published today in trade magazines, the engineer has all he can do in assembling the articles he comes across for future reference. This paper describes a private filing system for technical electronic subjects, product catalogs and electronic components.

In an effort to keep the number of departments as small as possible specialization has been minimized, but the filing system can be modified to incorporate special technological interests.

The departments are categorized by subject matter and items usually related with the department are listed under it. The listing can be expanded or more departments created as the need arises.

### *Filing Procedure*

Enter the technical article in the department to which it is related on a 4 x 6 card. An article may be placed in two or more departments. At the end of the entry, place department number, entry number and pack number. (See Figure 1.)

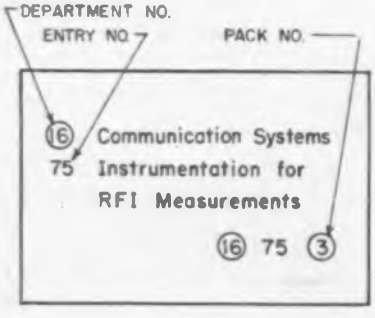


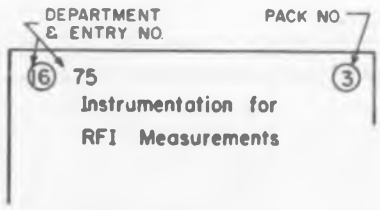

Fig. 1: The 4 x 6 file card tells what is available and where it is located. A brief summary of article may be included.

On the article itself, place department, entry and pack number. (See Figure 2.)

For an article in a magazine which can be obtained from the company library, enter the article in department to which it is directly related. At the end of the entry place magazine's name, date, month, year and page. (See Figure 3.)

After a sufficient number of articles have been accumulated, place them in an 8 x 15 envelope and mark with pack number. (See Figure 4.)

Fig. 2: The article itself should contain the Dept. and Entry Nos. in upper left hand corner and Pack No. in upper right hand corner.




When two or more articles are attached to the same page, write the numbers of the top article after the attached entry on the 4 x 6 card.

Write complete title on card—helps in finding article when an error of the article is published. A short abstract after the title will be helpful.

### *Retrieval Procedure*

In the retrieval of material it is simply a matter of reading the 4 x 6 cards of the appropriate department and picking out the entries of interest. The article can then be obtained from either the 8 x 15 envelopes or from the company library.

**Departments**

**1. Amplifiers**

| | |
|---|---|
| Audio Frequency | Tuned Amplifiers |
| Operational | Isolation |
| Frequency Converting | Direct Current |
| Distributed | Direct Voltage |
| Radio Frequency | Intermediate Freq. |
| Video | Pulse |
| AGC | Cath. & Emitter Followers |
| Voltage Regulating | Current Regulating |

**2. Antennas**

| | |
|---|---|
| TR Switch | Baluns |
| RF | Luneburg Lenses |
| FM | Diplexers |
| Microwave | Scanners |
| Measurements | TV |

**3. Audio**

| | |
|---|---|
| High Fidelity | Stereophonic Sound |
| Tape Recording | Telephone |
| Acoustics | Sound |
| Headsets | Microphones |
| Speakers | Magnetic Recorders |
| Magnetic Reproducers | Magnetic Tape |
| Magnetic Pickups | |

**4. Capacitors**

| | |
|---|---|
| Fixed | Variable |
| Voltage Controlled | Ceramic |
| Glass | Aluminum Electrolytic |
| Mica | Tantalum Electrolytic |
| Paper | Plastic |
| Vitreous Enamel | Air |
| Oil | Quartz |
| Vacuum | Reactance Simulators |
| Measurements | |

**5. Communication Systems**

| | |
|---|---|
| AM | FM |
| PM | TV |
| CW | SSB |
| FSK | Receivers |
| Information Theory | Transmitters |
| Radio Noise | RFI |
| Direction Finders | Measurements |

**6. Computers, Analog and Digital**

| | |
|---|---|
| Binary Counters | Ring Counters |
| Analog to Digital Conversion | Programming |
| | Pattern Recognition |
| Function Generators | Boolean Algebra |
| Data Processing | Inhibitor Ckts. |
| Decision Elements | Logic Ckts. |
| And, Or, Not, Nor Gates | Symbolic Logic |
| | Parametrons |
| Exclusively Or Gates | Shift Registers |
| Memory Ckts. | Encoders |

**7. Diodes**

| | |
|---|---|
| Zener | Reference |
| Signal | Switching |
| Rectifiers | General Purpose |

**8. Electro-Mechanical Hardware**

| | |
|---|---|
| Wire | Circuit Breakers |
| Cable | Light Sources |
| Harnesses | Identification Devices |
| Switches | Lamp and Fuse Holders |
| Fuses | Fans |
| Connectors | |

Fig. 3: This file card gives the title of an article in a magazine available from the company library. The card may be colored, giving a quick indication that the articles are not in the engineer's possession.

⑱ AMPLIFIERS

82 Analyzing a Realistic Cathode Follower

E I. May '61 P. 98

**9. Environmental Simulation**

| | |
|---|---|
| Shock Mounts | Shock |
| Effects of Radiation | Temperature |
| Corrosion | Vibration |
| Altitude | Moisture |
| Salt Spray | Sand-Dust |

**10. Filters, Delay and Transmission Lines**

| | |
|---|---|
| Low Pass Filters | Delay Filters |
| High Pass Filters | Band Pass Filters |
| Slot Filters | Selective Cathode Traps |
| Parallel T RC Ckts. | Attenuators |
| Measurements | Twin T Networks |

**11. Hydraulics and Pneumatics**

**12. Industry and Government**

| | |
|---|---|
| Standards | Publications |
| Books | Indexes |
| Libraries | Cataloging |

**13. Infrared, Optics and Photography**

**14. Magnetics**

| | |
|---|---|
| Inductors | Single Freq. Trans. |
| Transformers | Variable Inductors |
| Magnetic Amplifiers | Induction Potentiometers |
| Hall Effect & Devices | Ferrites |
| Magnetic Clutches & Brakes | Magnetostriction |
| | Toroidal Coils |
| Permanent Magnets | Saturable Reactor |
| Saturable-Core Trans. | Q Multipliers |
| Linear Differential Trans. | Reactance Simulators |
| | Magnetic Core Driver |
| Pulse Transformer | Ckts. |

Fig. 4: The 8 x 15 envelope containing the accumulated articles in a particular field of interest should be marked with Pack number.

PACK ③

**15. Management**

| | |
|---|---|
| Technical Writing | Personnel Data |

**16. Materials**

| | |
|---|---|
| Adhesives | Ceramics |
| Potting Compounds | Rubber |
| Solder | Tapes |
| Finishes | Encapsulating Compounds |
| Lubricants | Metals |
| Plastics | |

**17. Mathematics**

| | |
|---|---|
| Circuit Analysis | System Analysis |

**18. Measurements**

| | |
|---|---|
| Instrumentation | Test Euipment |
| Calibration | Strain Gages |
| Accelerometers | Pressure Transducer |
| Frequency Standards | Velocity Transducer |

## Cataloging . . . *(Continued)*

**19. Medical Electronics**

**20. Microwaves**

| | |
|---|---|
| Radar | Line Type Modulators |
| UHF | Doppler Radar |
| Masers | Waveguides |
| Parametric Amp. | Magnetrons |
| Directional Couplers | Isolators |
| Circulators | Klystrons |
| TWT | Traveling Wave Amp. |
| BWT | Optical Masers |
| Parametric Diodes | Varactors |
| Measurements | Techniques |

**21. Miscellaneous Devices and Systems**

| | |
|---|---|
| Fire Control Systems | Alarm Circuits |

**22. Multivibrators and Oscillators**

| | |
|---|---|
| Harmonic Osc. | Free Running MV |
| Relaxation Osc. | Flip-Flop MV |
| Synchronization | Mixers |
| Converters | Detectors |
| Discriminators | Tuning Indicators |
| Ringing Ckts. | Frequency Measurement |
| Resonance | Phase Shift Osc. |
| Frequency Multipliers | Demodulators |
| Freq. Crystals | Modulators |
| AFC | Voltage Controlled Osc. |

**23. Networks**

| | |
|---|---|
| Voltage Comparators | Voltage Level Sensing |
| Phase Measurements | Impedance Matching |
| D. C. Restoration | Frequency Dividing |
| Deflection Ckts. | Frequency Multiplication |
| Quantizer Ckts. | Differentiating |
| Clamping | Integrating |
| Limiting | Phase Sensitive Ckts. |
| Phase Shift Networks | Voltage Doublers |

**24. Power Supplies**

| | |
|---|---|
| Batteries | Constant Voltage |
| Voltage Regulators | Constant Frequency |
| DC to DC Converters | Variable Frequency |
| Constant Current | Dynamotors |
| Solor Cells | Energy Sources |
| Power Transfer Ckts. | Measurements |

**25. Production and Packaging**

| | |
|---|---|
| Microminiaturization | Solid Circuits |
| Printed Circuits | Packaging Techniques |
| Chassis Design | Production Processes |

**26. Pulse and Timing Techniques**

| | |
|---|---|
| Sweep Ckts. | Time Measurements |
| Blocking Osc. | Phantastrons |
| Pulse Generators | Sawtooth Generators |
| Staircase Generators | Delay Timers |
| Interval Timers | Repeat Cycle Timers |
| Transient Response | Pulse Shaping Networks |
| Trigger Circuits | Schmitt Trigger Ckts. |
| Sequence Timing Ckts. | |

**A REPRINT**
**of this article can be obtained by writing on company letterhead to**
**The Editor**
**ELECTRONIC INDUSTRIES, Chestnut & 56th Sts., Phila. 39, Pa.**

**27. Relays and Choppers**

| | |
|---|---|
| Solenoids | Frequency Sensitive |
| Arc Suppressors | General Purpose |
| Latching | Sensitive |
| Polarized | Mechanical Choppers |
| Stepping | Time Delay |
| Vibrators | Relay Drive Ckts. |
| Transistorized Choppers | |

**28. Reliability**

| | |
|---|---|
| Statistics | Quality Control |
| Human Engineering | Value Engineering |

**29. Resistors**

| | |
|---|---|
| Fixed | Computing |
| Variable | Linear |
| Non-Linear | Trimmer |
| Voltage Sensitive | Precision Pots |
| Measurements | |

**30. Semiconductor Switches**

| | |
|---|---|
| Raysistors | Controlled Rectifiers |
| Avalanche Switch | 4 Layer Bi-Stable |
| PNPN Switch | Photocells |

**31. Servomechanisms**

| | |
|---|---|
| Automatic Control | Servo Motors |
| Adaptive Control | Rate Generators |
| Open & Closed Loop Systems | Tachometers |
| | Gyroscopes |
| Lead & Lag Networks | Motor-Generator |
| Torque Motors | Resolvers |
| Synchros | Measurements |
| Gear Trains | |

**32. Space and Navigation**

| | |
|---|---|
| Missiles | Guidance |
| Satellites | Astronomy |
| Drones | Plasma Engines |
| Radio Astronomy | |

**33. Telemetering**

| | |
|---|---|
| Systems | Tape Readers |
| Data Reduction | Indicators |
| Readouts | |

**34. Temperature Compensation and Detection**

| | |
|---|---|
| Thermistors | Heat Flow |
| Sensistors | Cooling Methods |
| Thermocouple | Bias Stabilization |
| Heating Elements | Thermoelectricity |

**35. Tunnel Diodes**

| | |
|---|---|
| Backward Diodes | Circuits |
| Uni-Tunnel Diodes | |

**36. Transistors**

| | |
|---|---|
| NPN | Germanium |
| PNP | Silicon |
| Phototransistors | |

**37. Ultrasonic and Sonar**

**38. Vacuum Tubes**

| | |
|---|---|
| Receiving | Transmitting |
| Gas Filled | Phototubes |
| Nuvistors | Thyratrons |
| Cold Cathode | CRT |
| Beam Switching | Ceramic Tubes |
| Display Tubes | Nixie Tubes |

## News of Mfrs' Representatives

**R. C. Merchant Co., Inc.**, Detroit, Mich., has been appointed sales representative for John E. Fast Co., div. of Victoreen Instrument Co., Chicago, Ill.

**Lahana & Co.**, Denver, Colo., has been appointed engineering and sales representatives by Ingersoll Products, div. of Borg-Warner Corp., Chicago, Ill., to cover Colorado, Montana, Utah, Wyoming, and Southeastern Idaho.

Industrial Electronic Engineers, Inc., has announced the following representatives: **David G. DeHaas Co.**, San Diego, Calif. to cover San Diego; and **Gramer and Company**, Phoenix, Ariz., to cover Phoenix.

McLean Engineering Laboratories, Princeton, N. J., has announced the following appointments: **Lahana & Co.**, Denver, Colo., to cover Utah, Wyoming, Montana and Southeast section of Idaho; and **Neely Enterprises**, North Hollywood, Calif. for California, Arizona, Nevada and New Mexico.

**Gray-Bud Electronics Inc.**, Tenafly, N. J., has been appointed as representative by Slator Electric Inc., Glen Cove, N. Y., for their Semiconductor and Electronic Products Div. to cover Metropolitan New York and Northern New Jersey.

Chicago Dynamic Industries, Inc., Precision Products Div., Chicago, Ill., has appointed **Bauman and Bluzat**, Chicago, Ill., as representative in the state of Illinois.

Astron Sales Corp., East Newark, N. J., has appointed **Jack Brown Associates**, Yonkers, N. Y., as representatives in Metropolitan New York, Westchester County and Northern New Jersey.

**Straube Associates**, Palo Alto, Calif., appointed representatives for Silicon Transistor Corp., Carle Place, N. Y., to cover Northern California.

Struthers-Dunn, Inc., Pitman, N. J., has announced the appointment of **George W. Ledbetter & Assoc.** as representative to cover California.

**Maxson Electronics Corp.**, Maxson Instruments Div., N. Y., announces the following representative appointments: **Carse Electric Corp.**, Albany, N. Y. to cover upper New York State; and **Zaslow Sales Co.**, W. Hartford, Conn., to cover the six New England states.

GE's Silicone Products Dept., Waterford, N. Y., announces the appointment of **Smooth-On Mfg. Co.**, Jersey City, N. J., as representatives covering the East Coast, south of New England.

General Instrument Semiconductor Div. has appointed the following sales representatives: **Jack Logan and Assoc.**, San Francisco, Calif. for Northern California and Nevada (except Clarks County); **Electronic Components Sales, Inc.**, Denver, Colo., for Colorado and Utah; **Burt Porter, Inc.**, Seattle, Wash., for Washington, Oregon, Alaska, Idaho, and Montana; and **W. G. Henschen Co.**, Phoenix, Ariz., for Arizona.

Hamilton Watch Co., Precision Metals Div., Lancaster, Pa., announces the following sales representatives: **The Bauer Co.**, Ft. Worth, Tex., to cover the Southwestern states; **John C. Ott Co.**, Chicago, Ill., to cover the Western Great Lakes area; and **Vincent Brass & Aluminum Co.**, Minneapolis, Minn., for the North Central states.

Dresser Electronics, HST Div., Garland, Tex., has appointed **Ringland M. Kruegar Co.**, Chicago, Ill., as representative to cover Illinois and Northwest Indiana.

Frequency Engineering Laboratories has appointed **Bill Henry Assoc.**, Charlotte, N. C., as representative for North and South Carolina, Georgia, Florida, Alabama, Tennessee and Virginia (excluding D. C. area); and **Zak & Assoc.**, St. Louis, Mo., for Missouri, Kansas, Iowa, Minnesota, Wisconsin, Illinois and Indiana.

American Semiconductor Corp., Chicago, Ill. has appointed the following representatives: **Fred Spellman & Co.**, Manhasset, N. Y., to cover Metropolitan, New York, Long Island and Westchester County; **Gordon Fixman Engr. Co.**, St. Louis, Mo., for Missouri, Southern Illinois, and Kansas; **Burton F. Drill & Assoc.**, Phila., Pa., for Southeastern U. S.; **Stemler Assoc.**, Towson, Md., for Delaware, Washington, D. C., Maryland, New Jersey, E. Pennsylvania, and Virginia; **Space Engineering**, Pasadena, Calif., for West Coast; **Technical Sales Assoc.**, Dayton, Ohio, for Ohio, Indiana, Kentucky, W. Virginia, Western Pa., and Southern Michigan; and **Sales Assoc.** of New England, Somerville, Mass. for Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, and Connecticut.

# Industry News

**Dr. Harry Nyquist**, retired Bell Labs. engineer, has received the **Mervin J. Kelly Award** in telecommunications "for his fundamental role in the evolution of modern communication and control theories."

**Dr. Charles H. Townes**, Provost of MIT, was presented with the **David Sarnoff Award** "for research in resonance physics leading to major advances in communication technology."

**C. Daniel May, Jr.**—named Head, Tactical Communications Systems Dept., Federal Systems Div., International Business Machines Corp., Rockville, Md.

**Hayward K. Mann** — appointed General Sales Manager, Clevite Transistor, Div. of Clevite Corp., Waltham, Mass.

H. K. Mann

A. J. Girardot, Jr.

**Alfred J. Girardot, Jr.**—promoted to Director of Marketing, Semiconductor Div., Hoffman Electronics Corp., El Monte, Calif.

**Walter D. Pitts**—named Director of Materiel, Microwave Development Laboratories, Inc., Natick, Mass.

**Charles S. Tobias**—named Divisional Sales Manager, Mincom Div., Minnesota Mining and Mfg. Co., Los Angeles, Calif.

**Ronald C. Pittenger**—appointed as Advertising and Sales Promotion Manager, Industrial Instruments, Inc., Cedar Grove, N. J.

**Malcolm M. Morgan** — appointed Regional Sales Manager, New England Territory, Ultrasonic Industries, Inc., Plainview, L. I., N. Y.

The Garrett Corp., Los Angeles, Calif., announces the following appointments: **J. J. O'Brien** — named Vice President of the corporation; and **Jack Lewis**—named Vice President in Charge of Manufacturing.

Amperex Electronic Corp. announces the appointments of **Charles Roddy** — Technical Assistant to the President; **Ed King**—Assistant Product Manager, Professional Tubes and Semiconductors; and **Al Katz**—Assistant Product Manager, Transmitting and Power Tubes.

# Industry News

**Chester (Chet) Jur** — appointed Western District Sales Manager, John E. Fast Co., Chicago, Ill.

**Roger E. Gay**—named Managing Director, American Standards Assoc., New York, N. Y.

**James E. Harrison**—named Marketing Manager, Semiconductor Div., The Bendix Corp., Holmdel, N. J.

**Ray A. Zuck**—named Vice-President, Instrument Div., General Atronics Corp., Wyndmoor, Pa.

R. A. Zuck

C. F. Ivins, Jr.

**Clinton F. Ivins, Jr.** — appointed Vice President-Marketing, Quan-Tech Laboratories, Inc., Boonton, N. J.

**John N. Kilpatrick**—named Western Region Sales Manager, Times Wire and Cable Co., Inc., Div. of The International Silver Co., Wallingford, Conn.

**Robert K. Burns**—appointed Sales Manager, Cinch-Jones Div., Cinch Mfg. Co., Chicago, Ill.

**Wilhelm F. Juptner** — appointed Vice President, Babcock Relays, division of Babcock Electronics Corp., Costa Mesa, Calif.

W. F. Juptner

D. E. Teaford

**Dawson E. Teaford** — named Administrative Assistant to the President, Bourns, Inc., Riverside, Calif.

**Norman Albone** — appointed Manager, New Products Div., Microwave Components and Systems Corp.

**Merritt Steele**—appointed Marketing Manager, Computer Measurements Co., San Fernando, Calif.

**Claude T. Brown**—appointed Manager, Oceanography Div., Vector Mfg. Co., Southampton, Pa.

**Jerald R. Haegele** — named Manager, Accessory Products Div., Eitel-McCullough, Inc., San Carlos, Calif.

**Arch T. Hoyne**—appointed Mid-West District Sales Manager, Cornell-Dubilier Electronics, Div. of the Federal Pacific Electric Co., Newark, N. J.

**Edward L. Baughman** — promoted to Manager, Marketing Research, Lansdale Div., Philco Corp., Lansdale, Pa.

**Robert K. Burtner**—named Marketing and Sales Director of Industrial Electronic Engineers, Inc., N. Hollywood, Calif.

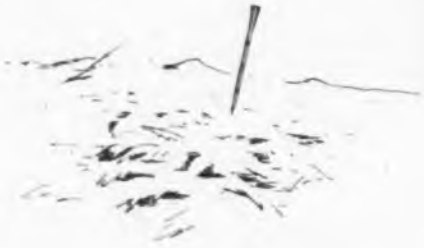
**John Jipp**—promoted to Vice President-Sales and General Manager, Sales and Service Div., Ampex Corp., Redwood City, Calif.

**Richard J. Newman**—promoted to Director of Planning and Development, The Daven Co., Livingston, N. J.

**S. Frank Buck** — appointed Sales Promotion Manager, Consolidated Electrodynamics Corp., sub. of Bell & Howell Co., Pasadena, Calif.

## Trail Marking

The aerial survey crew drops transponder to guide the ground party which is equipped with transceiver. Note antenna on the bulldozer.



(*Continued from page* 117)

a receiver-interpreter, which transmits the signal in impulse form to a read-out instrument. The information can then be presented in almost any manner desired by the people who are going to use the information, from a colored light to a typed page.

In its most simple form, the system, could consist of a hundred markers, or transponders, sufficient to cover ten miles of trail; plus a transceiver.

In this form, the transceiver might give just an audible or visible signal, to indicate that its antenna is pointed to one of the transponders.

In appearance, a basic system would have a transceiver, approximately 12 by 6 by 10 in., about the size of a small table radio. The transponders might look like 18 in. pieces of plastic rod, 1-in. thick. Those used for dropping by air, to mark trails through desert or forest, are steel-pointed on the nose end, so that they will stand at right-angle to the earth, ready to operate.

The range of each transponder is anywhere from 25 to 500 feet, depending upon the type of terrain in which they are used. Through rough terrain or jungle, it might be practical to drop the units as close as 25 to 50 ft. of each other. In open areas, such as snow plains, they may be as far apart as 400 to 500 ft., and still be effective.

Among the other uses for the Trailmarker, in addition to jungle and polar applications, is its use in surveying for pipelines, or long distance power transmission lines. * * *

# CATHODE-RAY OSCILLOSCOPES (Additions)

The following information supplements the data presented in EI's Survey of Cathode Ray Oscillators which appeared in the Oct. 1961 issue.

| TYPE NO. | V AMPL: FREQ (cps) RESP (db) w/n bands | V AMPL: RISE T μs | V AMPL: SENS. mv/cm | V AMPL: Z-IN meg/pf | H AMPL: FREQ cps | H AMPL: SENS. mv/cm | H AMPL: Z-IN meg/pf | SWEEP: FREQ (cps) SWEEP (cm) | SWEEP: EXP x1 | CRT | DIM. (in.) WT (lbs) | PRICE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **HEATH CO., Benton Harbor, Mich.** | | | | | | | | | | | | |
| 10-18 | DC-200KC | | .1v./¼" | 3.6-35 | DC-200KC | .1v./¼" | | 5cps to 50KC | | 3RP1 | 8⅜ x 4⅝ x 12⅜" | 79.95 |
| 10-21 | 2cps-200KC | | .25v./1" | 10-20 | 2cps-200KC | .25v./1" | 10-20 | 20cps to 100KC | | 3RP1 | 9½ x 8½ x 16" | 49.95 |
| 10-30 | 5cps-2.5MC | .08μs | .025v./1" | 2.9-21 | 1cps-400KC | .3v./1" | 30-31 | 10cps to 500KC | | 5UP1 | 8⅝ x 14⅛ x 16" | 69.95 |
| OP1 | DC-3.5MC | .1μs | .1v./cm. | 3.6-28 | DC-600KC | .2v./cm. | 1-37 | | | 5ADP2 | 8¾ x 14⅛ x 19" | 184.95 |
| OR1 | DC-200KC | | .1v./cm. | 3.6-28 | DC-200KC | .1v./cm. | 3.6-28 | 5cps to 50KC | | 5ADP2 | 11 x 6¾ x 20" | 119.75 |
| **LAVOIE LABORATORIES, INC., Morganville, N. J.** | | | | | | | | | | | | |
| LA-239D | 5-15M | .022 | 30 | 1-40 | | 1.6V | 1-30 | .17-37.5Kμs/in | 10 | 3" | 19½ x 15¼ x 16¾; 56½ | $1,500.00 |
| LA-260 | dc-20M[1] | .02[1] | 10 | 1-22 | 10-750K | 1V | | .02μs-15s | 10 | 5" | 19½ x 14 x 17; 80 | 2,198.00 |
| LA-265 | dc-30M[2] | 12NS[2] | 50 | | DC-300K | 200 | 1-47 | .02μs-12s | 5 | 5" | 13 x 16⅜ x 24; 66 | 1,460.00 |
| LA-270 | dc-70[4] | 5NS[3] | 50 | 1-20 | 5-2M | 1V | | .01μs-15s | 10 | 5" | 14⅜ x 17 x 23; 78 | 1,985.00 |

1. With S60 or D60 plug-ins; 2. With 265L plug-in; 265B; 20M; 265D; 2M; 265CA; 24M; 3. With 265L plug-in; 265B; 18NS; 265D; 18μs; 265CA; 15NS; 4. With S70 plug-in; D70; 50M; 5. With S70 plug-in; D70; 7NS; 6. With S75 plug-in.

# Dielectrics

(*Continued from page* 116)

ture. This uniformity stems from the fact that the TFE resin and glass fibers are brought together by means of a beater addition process, very closely related to techniques employed in producing paper. In this process, the resin is added to a dilute suspension of glass fibers in water. The resin becomes a part of the fiber dispersing medium, with the result that the individual fibers are actually coated or encapsulated in the resin.

The end material is homogeneous. Fiber distribution is uniform. There are no resin-rich or resin-starved areas. The fiber contributes mechanical strength and greater resistance to temperature under load, but remains essentially in a secondary role insofar as electrical properties are concerned. Fiber encapsulation results in surface characteristics that, like TFE itself, minimize energy absorption.

Another advantage of the material's construction is the absence of any wicking effect in the presence of moisture, again because of fiber encapsulation. Figs. 1 and 2 compare the effect of water immersion on Duroid 5870 (TFE-glass fiber) and on TFE-glass cloth laminate with respect to dielectric constants and dissipation factors.

Present uses of the material are in a classified category and can only be referred to as being in the area of microwave transmission.

## EIA AWARD

W. T. Wintringham (l), head of the visual systems research department of Bell Telephone Labs, receives plaque from V. M. Graham, associate director of the Electronics Industries Association engineering department. Award was made at the dinner of the 33rd annual Radio Fall Meeting. Plaque is awarded annually "for achievements contributing to the industry's technological progress."

## Nuclear Blasts & Unreliability

(*Continued from page* 123)

tended to give the engineer a good working knowledge of the subject.

Having this outline, we went to people actively engaged in this work to write these articles. The first of the series will appear in our January issue. Here is an outline of our series of four articles. This will by no means be all that we intend to publish. This information will establish a basis upon which we can expand later, while giving you an immediate working knowledge.

1. Tutorial about nuclear radiation:
   - Description of the terms and units used
   - Description of types of reactors and radiation equipment available
   - Types of radiation and their general effects
   - Measuring and monitoring devices
2. Effects of Nuclear Radiation on Electronic Materials:
   - General-Reasons for pulsed reactors
   - Effects of radiation on insulating materials
   - Effects of radiation on metals
   - Effects of radiation on semiconductor materials
   - Effects of radiation on gases (ionization)
   - Effects of radiation on other materials
3. Effects of Nuclear Radiation on Electronic Components & Equipment:
   - General introduction as to field effects on equipment (how radiation can knock out equipment)
   - Effects of radiation on electronic components
   - Problems connected with evaluation of components for nuclear effects and hardening
   - Design considerations to improve immunity
   - Effects of radiation on circuits and systems
4. Equipment Design and Packaging for Nuclear Exposure
   - Locating most susceptible items in center of units
   - Packing equipment with radiation resistance materials
   - Design considerations to make equipment more immune to radiation
   - Other preventative measures

### POWER FOR SPACE TRIPS

**Glow of ionized atoms shooting out of this working ion engine is viewed by a technician through a porthole in a space simulation chamber at Hughes Aircraft Co.'s labs in Malibu, Calif. Developed by Hughes for NASA, the engine is the first of a family of such devices which company scientists say may be the ultimate form of propulsion for long trips into space.**

# ANNUAL INDEX of Articles–1961

*The annual index of ELECTRONIC INDUSTRIES has been arranged by subjects for easy reference to related topics. The first figure indicates the month in which the article appeared; the second figure indicates the page number.*

### COMMUNICATION SYSTEMS



### COMPONENTS—CHASSIS ELEMENTS



### COMPUTERS



### CONVENTIONS



### CUES FOR BROADCASTERS



### EDITORIALS



### GENERAL



*(Continued on page 231)*

# ANNUAL INDEX OF ARTICLES



### INSTRUMENTS, MEASUREMENTS, TEST METHODS



## TEST FACILITY

**These huge chambers are exhausted of air and fitted with equipment which permits the test of space and missile components under conditions simulating cold of outer space, solar heat radiation and other hazards. Envirovac test facility made by High Vacuum Equipment Corp., Hingham, Mass., is capable of testing a four-ton satellite.**

### MICROWAVE



### PRODUCTION METHODS



### RADIO FREQUENCY INTERFERENCE



### RELIABILITY



### SEMICONDUCTORS

### SPACE AND AIRBORNE VEHICLES



### SYSTEMS



### PAGE FROM AN ENGINEER'S NOTEBOOK



### TUBES



### What's New

#### COMPUTERS



#### COMPONENTS



#### GENERAL



#### MEASURING EQUIPMENT



#### PRODUCTION



#### SEMICONDUCTORS



#### TELEVISION



## AUTHOR'S INDEX



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# ANNUAL INDEX OF ARTICLES

## AUTHOR'S INDEX (Cont.)



## NEW TECHNIQUE

**L. H. Germer (left) and A. U. MacRae of Bell Telephone Laboratories with apparatus used in a new technique, perfected by Germer, for studying absorption of monolayers of gas on a crystal surface. The low energy diffraction technique is yielding information of great value in studies of surface effects such as catalysis and corrosion.**

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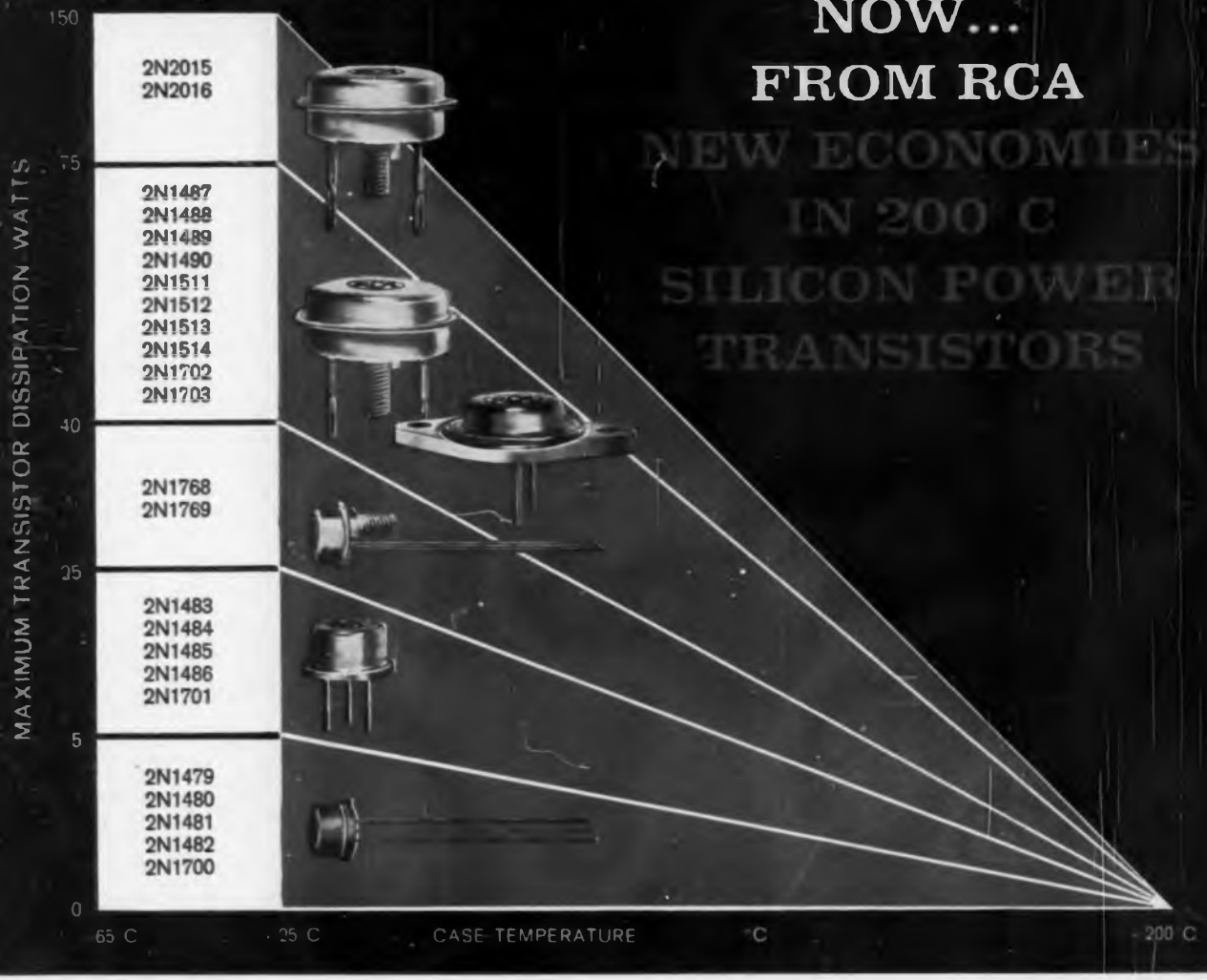


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