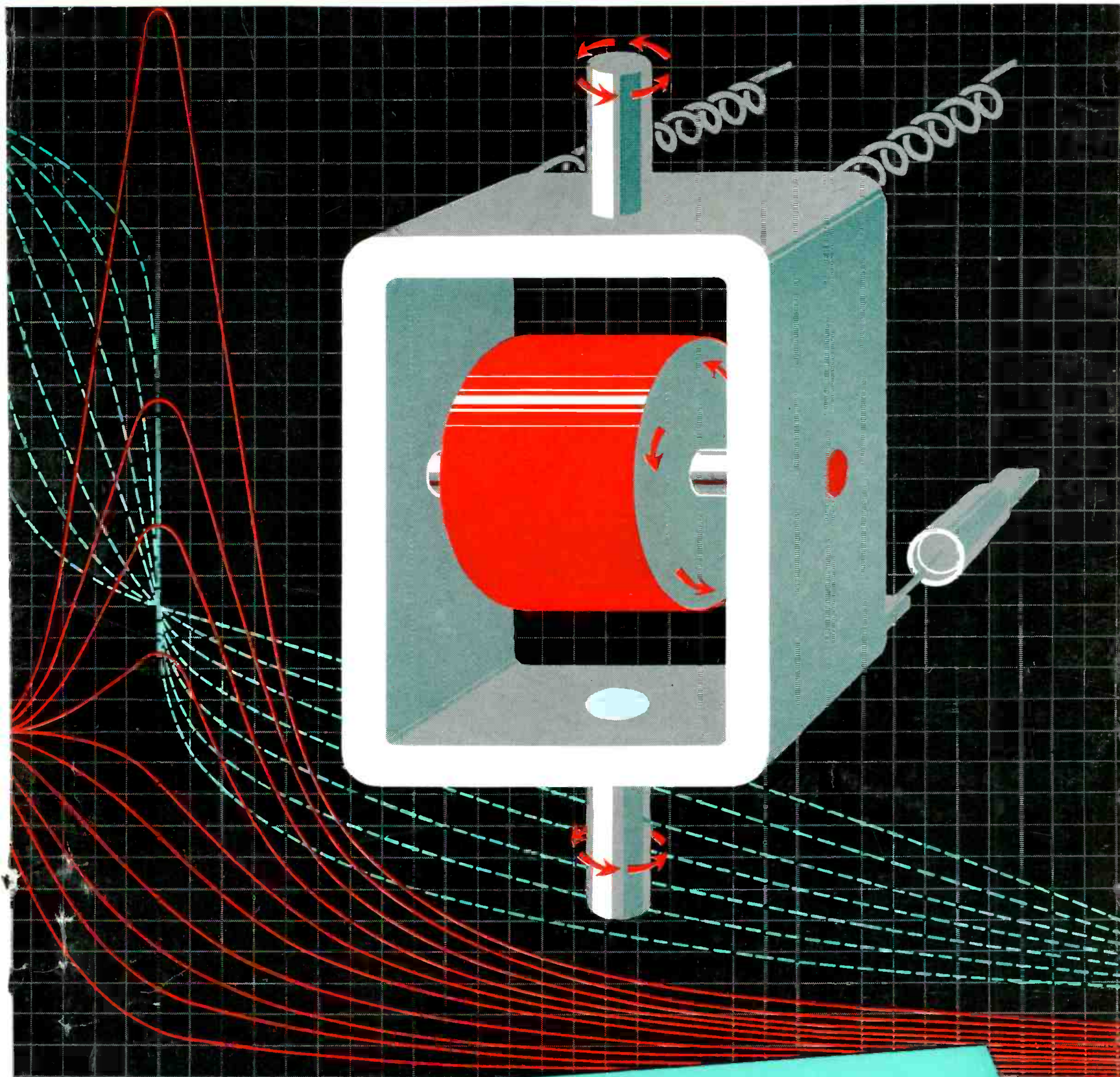
ELECTRONIC INDUSTRIES

A CHILTON PUBLICATION



- Analyzing Rate Gyro Dynamic Response—page 70
- The Systems Engineer—page 238

December
1959

Is inner-space your problem?

RMC Subminiature TYPE SM Discaps

If your designs continually shrink allowable space for components RMC's Type SM DISCAPS are the answer for capacitors. These subminiature DISCAPS can be specified with assurance of the quality, dependability and performance inherent in all DISCAPS.

Type SM meet the specifications of EIA-RS-198 for Z5U capacitors and are available in values of 800, .001, .0015 GMV; .005 + 80% — 20% ± 20%; .01 + 80% — 20% ± 20% and .02 + 80% — 20%. Capacity change between + 10°C and + 65°C is a minimum.

SPECIFICATIONS

POWER FACTOR: 1.5% Max. @ 1 KC (initial)
WORKING VOLTAGE: 500 V.D.C.
TEST VOLTAGE (FLASH): 1000 V.D.C.
LEADS: No. 22 tinned copper (.026 dia.)
INSULATION: Durez phenolic (1/8" max. on leads)—vacuum waxed
STAMPING: RMC—Capacity—Z5U
INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms
AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms

DISCAP CERAMIC CAPACITORS — RMC

RADIO MATERIALS COMPANY
A DIVISION OF P. R. MALLORY & CO., INC.
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
Two RMC Plants Devoted Exclusively to Ceramic Capacitors
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.

Circle 1 on Inquiry Card

ELECTRONIC INDUSTRIES

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

Guidance Feedback

This is the last issue for the 1950 decade and the occasion has caused us to pause and reflect somewhat on the growth and changes within the Electronic Industries over the past ten years. When one thinks about such things as growth and devolopment of transistors and semiconductor products, the rise of high fidelity, the march of the microwaves, the space electronic era, and the development of nearly 30 specialized fields of electronic engineering endeavor as being just a few of the many things that have happened, one cannot help the feelings of amazement, awe, and pride and personal satisfaction with an industry that follow. When one looks ahead to the next decade and tries to speculate what will happen, the horizons appear limitless and the matter of trying to keep an engineering publication editorially abreast of the changing situations becomes a seemingly impossible and even frightening task.

Fortunately over the years engineering editors have developed a number of checking procedures and methods to aid in properly orienting their editorial efforts. First among these, of course, is the direct personal contact in the field with readers. Such contact can be in the actual manufacturers' establishments, at conventions and shows, or in the regional or home editorial offices. Another source of guidance information comes through periodic editorial surveys conducted by research organizations, whose activities are independent from those of the publication. Then there are the periodic surveys conducted by the editorial department itself. Still other informational sources involve analyzing reprint requests and readers' letters. A month-to-month analysis of the volume of inquiries received for various products advertised or mentioned editorially is also frequently illuminating and revealing.

Occasionally there's additional data from the unexpected. For example, perhaps you will remember Bob McKenna's (the publisher) letter to you about the beginning of August. In this letter he asked for a show of hands as to why you, the reader, liked EI. The enthusiastic response came as a complete surprise. More than 4000 voluntary letters arrived from all over the country.

The content of these letters is fascinating. Many make specific reference to both current articles and articles that appeared as far back as 4 years ago. There's also mention and comment on every single department appearing regularly in EI.

Because it was difficult to detect any running pattern in reading through all the letters the Chilton Research Division was asked to perform a "content" analysis. This study, now completed provided all sorts of interesting data. For example, of the letters received 78% gave a positive indication as to the exact job title of the writer and all of these are associated with applied design engineering. Letters evidencing direct interest in articles by referring either to the types or subjects of the articles published total 69%. Specific departments such as What's New, Coming Events, Professional Opportunities, Totals etc. are mentioned in 37%. Another 27% make specific reference to an advertisement or advertiser. 43% mention something about the object and place of reading, and 14% include information on how long they have been receiving EI. Another 29% tell how they use the magazine such as sending in inquiry cards, clipping and filing articles, circulating the magazine to others etc.

These are only a few of the percentage figures that have become available through this survey. In the overall the study contains 15 areas of analysis with detailed statistical information.

Why do we mention this? Well, first we'd like to express our appreciation to those readers who wrote and expressed their opinions. Secondly, we thought you would be interested to know that the feedback you provide is being analyzed and used in an effort to provide you with a constantly improving magazine product. And finally, we believe readers should have an awareness of the importance to themselves of such "informational" type data requests. We look at them as the guidance-feedback systems which will ultimately return to the reader a magazine product of maximum practical use and interest, and continue to make E.I. the number one engineering publication in this field. Again many thanks for your letters!

ELECTRONIC INDUSTRIES, December, 1959. Vol. 18, No. 12. A monthly publication of Chilton Company. Executive, Editorial & Advertising offices at Chestnut & 56th Sts., Phila. 39, Pa. Accepted as controlled circulation publication at Phila., Pa. $1 a copy; Directory issue (June), $5.00 a copy. Subscription rates U. S. and U. S. Possessions: 1 yr. $10.00; 2 yrs. $18.00. Canada 1 year, $12.00; 2 yrs. $20.00. All other countries 1 yr. $18.00; 2 yrs. $30.00.

ELECTRONIC INDUSTRIES

Vol. 18, No. 12 **December, 1959**

MONTHLY NEWS ROUND-UP

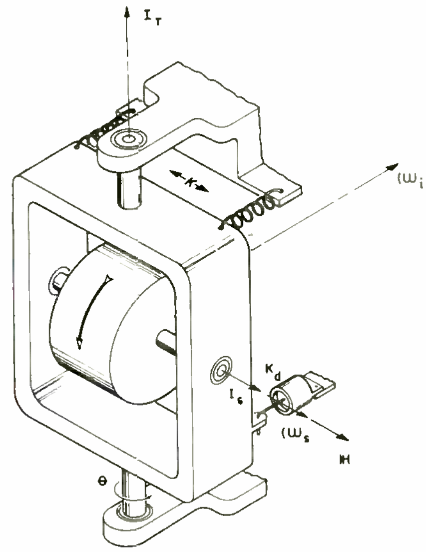
NEW PRODUCTS & TECH DATA

DEPARTMENTS

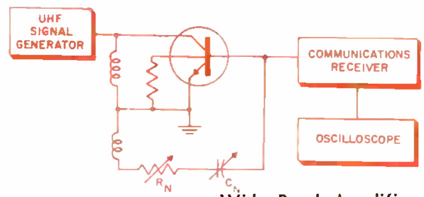
BPA NBP

Highlights

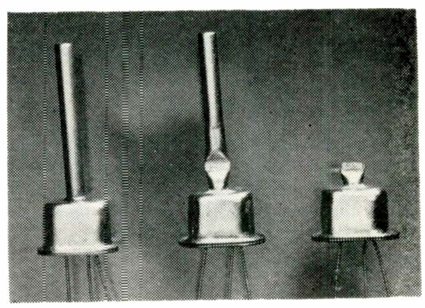
of this issue



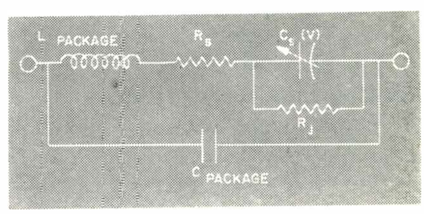
The Rate Gyro!



Wide-Band Amplifiers

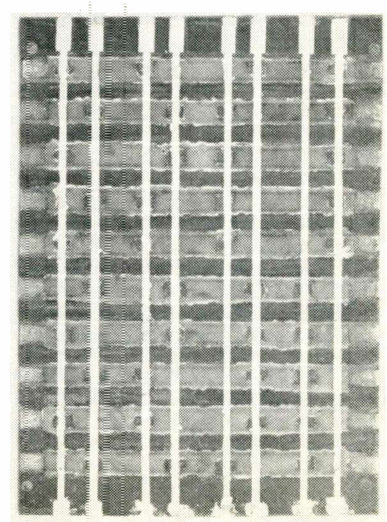


Tecnetron

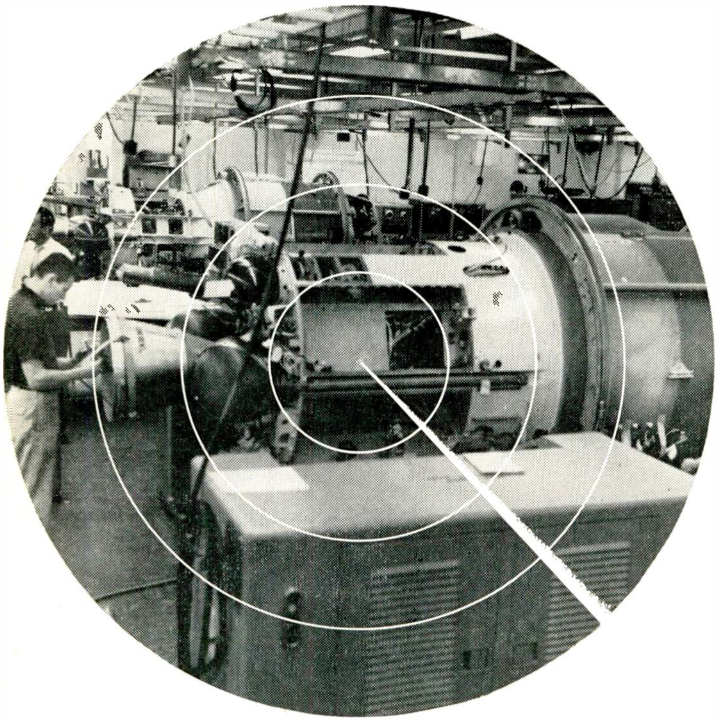


Varicap!

Printed Matrices



RADARSCOPE



SPACE SATELLITES

AGENA satellites being launched in ARPA's scientific Discoverer program go through modification and checkout of complex electronic equipment at Lockheed's Missile and Space Div., Palo Alto, Calif. After checking and firing in static test stands, satellites are launched into polar orbits by the Air Force.

CALIBRATION AND MEASURING centers will spring up around the country during the next few years. Most will be established by test instrumentation manufacturers, a few others by large electronics companies with field measurement problems of their own who see a way of turning a service problem into a profitable business. The need for calibration centers is acute today, and many in the industry are aware of it.

NEW 23-INCH CRT, with 114° deflection, will be offered to set makers within a few months. The new model does not have the bonded on implosion plate.

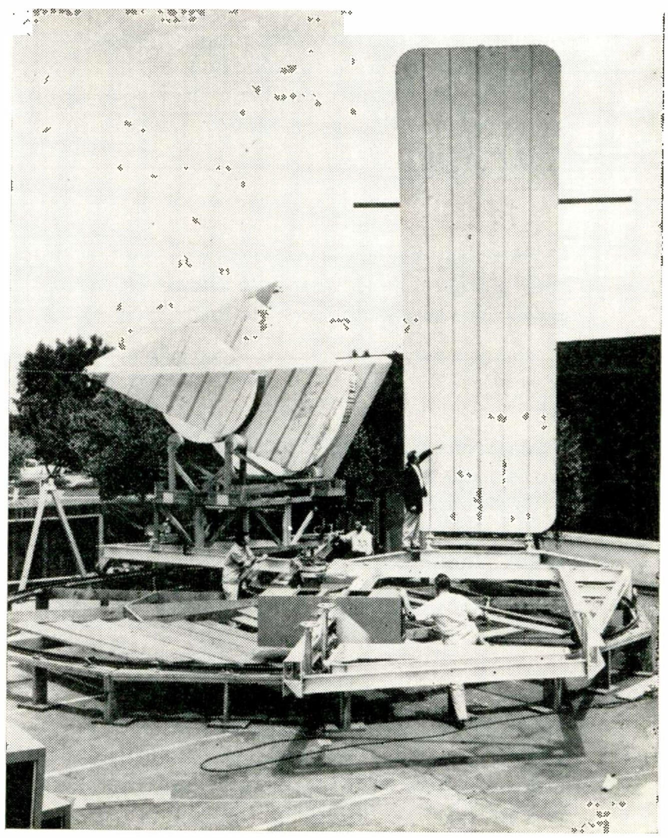
JAPAN is making its first concerted effort to penetrate the U. S. market with transistorized scientific and industrial instruments. Tokyo Shibaura Electric Co. Ltd. (TOSHIBA), Japan's leading electronic industrial company and largest manufacturer of transistors, exhibited 10 transistorized measuring instruments at the IAS Show in Chicago. Prominent were recorders and indicators, vibration measuring equipment and insulation testers.

NEW APPROACH to picture-on-the-wall TV is being explored by Lear, Inc. They are experimenting with electroluminescent displays for aircraft pilots, about ⅛ in. thick, with better definition in brightness than picture tubes. The phosphor research is reportedly completed.

"INFORMATION SCIENTISTS" who would have central responsibilities for seeing that all information from all sources promptly reaches the people who can use it, could greatly increase the effect of American technological advances, says John C. Green, Director of the Office of Technical Services, U. S. Department of Commerce. He suggests two immediate steps: More license arrangements to permit several companies, large and small, to pool their research findings; and second, a more thorough use of reports being issued by Federal Government Agencies. One thousand of these reports are being issued monthly.

NEW MILITARY ANTENNAS

The extremely wide band requirements for electronic warfare weapons has prompted work on improved antennas at Sylvania's Electronic Defense Labs in Mountain View, Calif. These antennas are typical. Antennas have been built having constant medium gain and impedance characteristics over a 30-to-1 frequency band.



Analyzing current developments and trends throughout the electronic industries that will shape tomorrow's research, manufacturing and operation

ELECTRONIC TRAFFIC CONTROL SYSTEMS are being considered as a means for eliminating critical freeway congestion. The electronics systems would activate certain signs and signals at freeway approaches advising drivers to take alternate routes.

CATHODE RAY TUBES now in the developmental stage require only 200 mw heater power. Experimental units have been constructed that require only 75 mw heater power.

VALUE ENGINEERING COURSE, first ever held, will start in Boston on November 30th at the Industrial Education Institute. The 5-day course has been designed for men responsible for product design, procurement and manufacturing in industry and government. The "faculty" includes most of the top value engineering leaders in the country.

RELIABILITY CENTER has been established at Battelle Memorial Institute's, Columbus, Ohio, laboratories, supported by eleven of the nation's largest users of manufacturers and electronic components. It will pool reliability data generated by the participating firms and conduct research toward improved reliability techniques. Invitations are being extended to other industrial firms to participate in the project.

INTERNATIONAL STANDARDS on "common language for machine searching and translation" are being drafted by representatives from 10 countries. Proposals are being considered for intermediate, common and universal languages, and for interconvertibility among languages and for advanced application of computer information systems in the automation or the research process.

"ROD" SWITCHING-STORAGE UNIT developed by the National Cash Register Co., Electronics Div., and acclaimed on its introduction some months back as being one of the most promising computer elements, has received a $75,000 contract from the Cambridge Research Center of ARDC. Under the contract NCR will conduct an investigation to improve and control the switching speed, saturation magnetization, squareness of hysteresis, coercive force. The research will serve as a background for the ultimate development of a general purpose solid state airborne digital computer. Rod-type computers would be much less bulky than core-types. It is possible to wind 10 bit-positions per linear inch along the rod without mutual interference. Packing densities of 1000 bits per cubic inch have been achieved.

OVERSEAS TV is exploding. During the past 12 months the number of TV receivers outside the U. S. has increased by 43%, the number of television stations by 63%. The number of sets outside the U. S. now total 33,725,000.

CHIEF SUBJECTS of discussion at the meeting of the Professional group on Electronic Devices were tunnel diodes, low-noise amplifiers, and multi-functional devices.

NATIONAL STEREOPHONIC Radio Committee is making significant progress towards standardizing on an FM stereo broadcasting system. The three prominent systems using AM subcarriers have been evaluated with the following results: The GE system is the least expensive because the receiver does not need to reconstruct the subcarrier. Philco and Zenith are very similar and can be expected to provide superior monophonic and stereophonic reproduction, although the receivers are more complicated. Still to be heard from are the proponents of FM systems with FM subcarriers—Crosby, Halstead and Calbest.

(*RADARSCOPE continues on page* 261)

PINPOINT PATHFINDER

The U. S. Army's master navigation system, developed by Sperry, is being checked out in this R4D test aircraft. Map display on pilot's knee is pierced by moving beam of light to continuously pinpoint exact position of plan in flight. Components of system may be varied, to provide any degree of automatic navigation.

As We Go To Press . . .

250 Missile Projects Since World War II

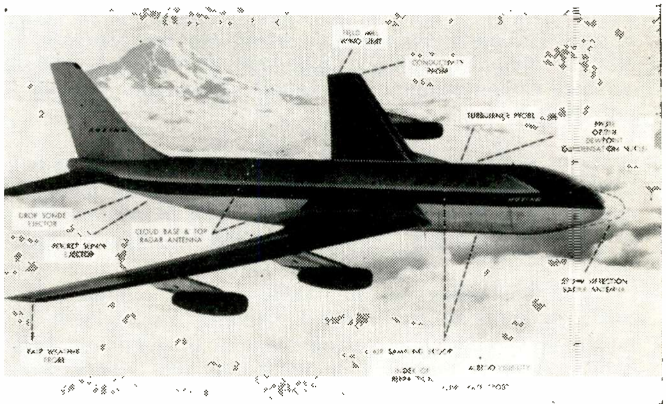
More than 250 U. S. missile projects have been started since World War II, according to the Association of Missile & Rocket Industries.

The total includes all types of "birds," from small sounding rockets to giant ICBMs. At least 30 are known to be discontinued and at least 20 out of production. Many others, in preliminary stages, may not go beyond a few test firings or even get off the drawing board.

This leaves close to a hundred active missile projects of substantial scope and cost, and doubtless others not yet revealed. Over the past year, new missile names have appeared at the rate of one or two a week.

Of the 250-odd missiles, approximately 60 are Army; 80 Navy; 90 Air Force; a dozen NASA; and a dozen not yet taken by any of the services.

WEATHER LABORATORY



The jet aircraft is crammed with electronic sensing and computing devices for gathering and analyzing weather data. Some of the main features are indicated. The laboratory was a major cooperative experiment between the Air Force, Navy, Weather Bureau, Bendix and Boeing.

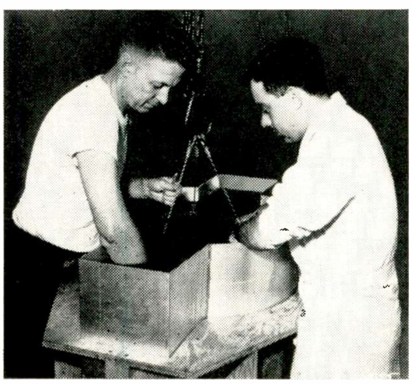
New Department To Service Computers

The RCA Service Company has established a separate department to install and service the RCA "501" electronic data processing equipment.

The new activity known as the Electronic Data Processing Services, will operate under the direction of G. W. Pfister, Vice President, Commercial Services.

RCA currently has contracts for installation of more than 40 of its electronic data-processing systems.

HOT OIL KEEPS OUT AIR



Martin Co. engineers are using castor oil at 100° F to keep air out of an electronic transducer assembly. Assembly is used in Martin's Sonar. Rubber shells prevent short-circuiting when transducer is immersed in water. Castor oil, a dielectric, is also a sound energy conductor.

FCC Petitioned To Aid Educational TV

Rules to permit the development of multichannel educational TV broadcast systems and ETV networks are being proposed to the FCC by Adler Electronics, Inc. The program would permit educators to make effective use of readily available UHF TV channels.

To achieve maximum benefits from the UHF frequencies, the petition calls for local origination as well as off-air pickup by translators, additional ETV translator channels, mileage separation on a non-interference basis, and waiver of the duopoly requirement. These rules will enable a number of educational groups to carry out their plans for low cost "on-air" stations to serve both schools and homes.

Contending that FCC approval of the proposed rules will stimulate widespread growth of educational TV, Adler Electronics points to such advantages of the upper portion of the UHF spectrum as availability of channels, economical equipment and operating costs, and reliable performance. The petition explains how the technical problems that have plagued UHF TV broadcasting can be overcome to make these channels attractive to educators.

Seek To Establish Low Freq. Standards

As a primary step in establishing the rigid electronic standards necessary for today's advanced technology General Radio Co. is launching an educational program for industry personnel concerned with maintaining standards.

The immediate concern is establishing capacitance and inductance measurements at low frequencies.

The program is being conducted with the cooperation of the National Bureau of Standards and various branches of the armed services.

W. R. Thurston

I. G. Easton

The program got under way last month with top technical personnel from several primary standards laboratories of the Armed Forces and the National Bureau of Standards attending a 3½-day seminar at the General Radio Co. laboratories, West Concord, Mass.

The seminar featured a plant tour with emphasis on the manufacturing of precision standards,

(*Continued on page 12*)

ELECTRONIC SHORTS

▶ Additional materials that can be used for thin film electronic components have been brought to light by research at Battelle Memorial Institute. The materials include certain nitrides, silicides, and oxides. Wright Air Development Center sponsored the research. These film materials promise to complement and extend advantages already provided by existing films.

▶ The U. S. Army Office of Ordnance Research, Pasadena, Calif., has contracted with Aerojet-General Corp. to conduct basic research studies of electrically exploded wires and films. The contract is the first ever awarded by this Army agency to a private industrial firm for this type of research.

▶ Scientific testing of air traffic control equipment and evaluation of traffic patterns by the Federal Aviation Agency will be made possible by means of the Bureau of Research and Development test range now being installed near Atlantic City. FAA has just awarded a $358,000 contract for the timing and communications portion of the test range to the Electronic Engineering Co., Santa Ana, Calif.

▶ An advanced, more sophisticated address reader for the Post Office Dept. will be developed by the Intelligent Machines Research subsidiary of Farrington Mfg. Co., Alexandria, Va. A $114,000 contract calls for "advancing the development of electronic analyzing, automatic reading equipment, and for producing an engineering test model of a completely automatic letter sorting machine."

▶ A precise radio navigation system, the Bendix-Decca, provides "electronic sea lanes" for all ships using eastern Canadian waters, including the approaches to the St. Lawrence Seaway. The Canadian government purchased the $2,350,000 system from Computing Devices of Canada Ltd., an affiliate of the Bendix Aviation Corp.

▶ A method of casting optical-quality silicon for use in infrared sensors in military weapons systems has been perfected by Hughes Aircraft Co. metallurgists. The new process permits volume production of silicon lenses, domes and flats.

▶ Using new electronic data processing methods, the USAF will shortly be able to screen the knowledge of 15,000 top U. S. scientists in a day or less, where months were heretofore required. The principal objective is to identify and locate the scientists and engineers, among 9,000 contractors, who are best qualified to answer urgent technical questions which are the key to management decisions.

▶ Magnetic gating amplifiers driving silicon controlled rectifiers in power control units may replace conventional electromechanical equipment such as amplidynes and motor generator sets. Developed by Magnetic Amplifiers, Inc., universal power control units provide voltage/current regulation, ac servo motor control, dc motor speed and position control, and temperature and light dimming control.

▶ Heart beat information will be analyzed and compared by a high-speed computer developed at National Bureau of Standards. It may help make statistical studies needed to establish more accurate limits for normality. In the analogdigital converter, electrical signals associated with heartbeats are converted from continuous waveforms to digital form on magnetic tape, then used in the computer for comparison either with normal record for diagnosis or with group of records for statistical purposes.

▶ A high-speed recording system that "reads" the magnetic tapes from electronic computers and instantly puts high-quality characters on microfilm has been developed by Eastman Kodak Co. The system is called Dacom—for Datascope Computer Output Microfilmer.

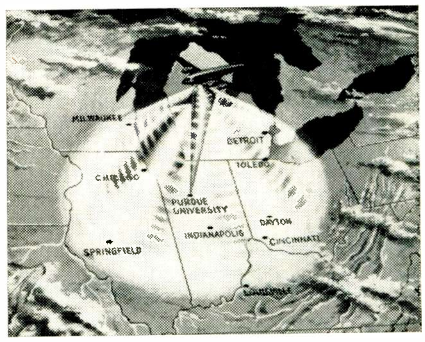
▶ A sonar trainer that stimulates submarine electronically is being produced by Raytheon Company, North Dighton, Mass. The trainer fakes all real submarine maneuvers including dives, varying courses, speed changes and torpedo attacks. Its synthetic, targed, indistinguishable from real, "echoes" may be cleared from sonar scopes immediately should a second target appear.

As We Go To Press

Circling DC-7 Will Telecast to 6 States

One of the most ambitious attempts ever made to educate masses of children through the medium of TV will begin in the Fall of 1960 in the six-state region surrounding Lafayette, Ind.

A DC-7 aircraft, circling at 20,000 ft., will telecast classroom courses simultaneously to an estimated 13,000 schools and colleges, with an enrollment of 5,000,000 students. Program will be actually originating at Purdue Univ., with the DC-7 acting as a relay station.



Six-state area covered by airborne TV

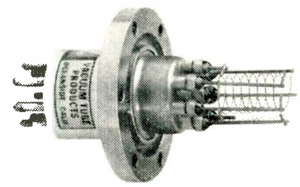
Cost of the first year's operation is expected to be about $7,000,000. Ford Foundation is contributing $4,500,000 to the project.

Application has been made to the FCC for two UHF channels for immediate use. A third channel is expected to be in operation eventually.

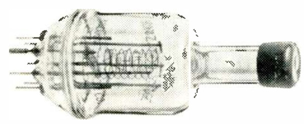
Basis for the program was laid by the "Stratovision" experiments conducted by Westinghouse in 1945-1948. Using a modified B-29 aircraft equipped with a television transmitter they delivered a satisfactory picture to receiving sets as far away as 225 miles in all directions. The Westinghouse engineer on that project, Charles E. Nobles, is technical adviser to the midwest operation, known by the title, Midwest Council on Airborne Television Instruction.

In the interest of increasing channel space experiments will be conducted with "narrow band" telecasting on two special channels which will carry the same programs as the conventional UHF channels. This narrow-band method was developed by CBS Laboratories, with the cooperation of Minnesota Mining & Mfg. Co.

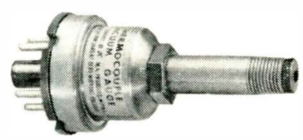
High-vacuum measurement–all types –one source



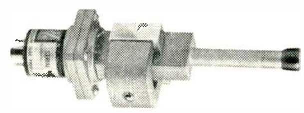
VTP 6578 IONIZATION GAUGE TUBE Especially designed for high ultimate vacuum applications, 3 filaments for long life. Reliable, positive calibration. Flanged for use in metal vacuum systems.



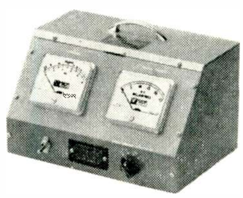
VTP 7169 IONIZATION GAUGE TUBE All glass. Designed for use in glass vacuum systems. Electrically identical to VTP 6578. Both may be outgassed easily by passing heater current through grid structure.



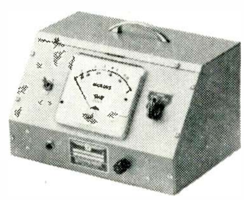
VTP 6343 THERMOCOUPLE GAUGE TUBE *Fast response: less than 0.1 second!* Pressure range: 0.1 to 1000 microns. Ruggedized all-metal construction. Useable for leak detection on vacuum systems as well as absolute pressure measurement.



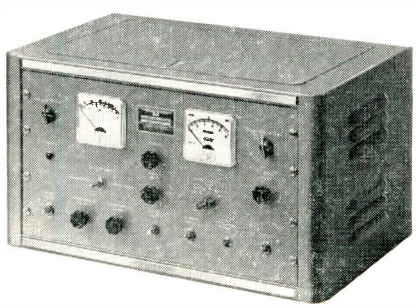
VTP PG-25 COLD CATHODE DISCHARGE TUBE Small, rugged, non-burnout, all-metal gauge tube for precise measurements and contaminating atmospheres. Easily dismantled for cleaning. Positive and accurate under all conditions.



VTP TC-43-1 THERMOCOUPLE GAUGE CONTROL Dual meter control. Indicating meters for heater current and system pressure. Rotary switch permits selective measurement of pressure at any one of four separate measuring points.



VTP PGC-25-01 DUAL RANGE PHILIPS GAUGE CONTROL Simple, inexpensive and rugged Philips gauge (cold cathode) control measures pressures in two ranges: (1) from 25 microns to 0.1 micron, (2) from 0.11 micron to 0.01 micron.



VTP 3-147 IONIZATION/THERMOCOUPLE GAUGE CONTROL
Dual thermocouple control combined with ionization gauge control. Automatic lockout protects ionization gauge tube. Contact meter optional.

For your laboratory and production use, the world's most complete line of vacuum measurement devices is available from Vacuum Tube Products.

Backed by over 13 years of research, development and production experience in the high-vacuum field, these precision instruments offer you the maximum in accuracy and reliability—*plus long operating life!*

Precise, dependable VTP vacuum gauge tubes are especially designed to give you extra-long life *plus* interchangeability in existing systems.

For detailed information on VTP's complete line of vacuum gauge tubes and controls—or sound solutions to your particular vacuum measurement problems, write:

Vacuum Tube Products
P.O. Box 90427
International Airport Station
Los Angeles 45, California

For export information, write:
Hughes International
Culver City, California

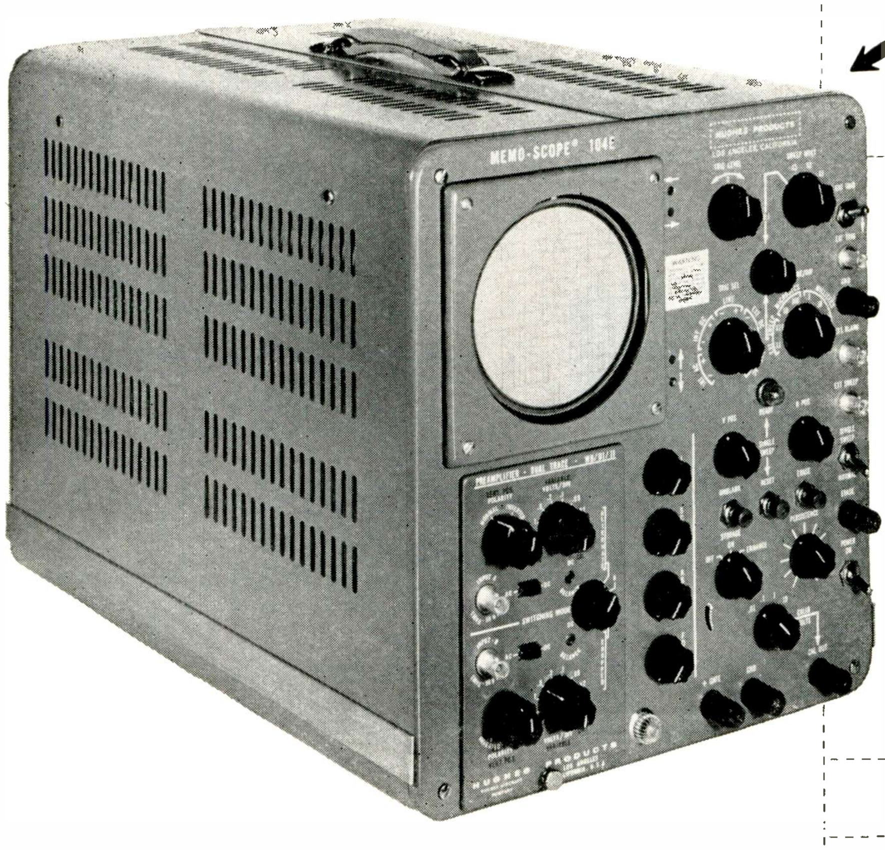
VACUUM TUBE PRODUCTS
a division of HUGHES AIRCRAFT COMPANY

Circle 3 on Inquiry Card

new improved "Memo-Scope®" oscilloscope

Still using "old-fashioned" methods for measuring non-recurring transients? If so, now is the time to investigate the easy way to solve your most difficult transient measurement problems with the latest model Hughes "Memo-Scope" oscilloscope.

Why? Because *new* features, *new* advanced circuitry, *new* panel layout and *new* mechanical design now assure maximum accuracy in all your transient measurements—*plus* higher performance, greater dependability and easier operation!



The Hughes "Memo-Scope" oscilloscope (Model 104E) stores nonrepetitive events for an indefinite period—hours, or days—keeping them available for thorough study until intentionally erased.

new improved features

- Simplified panel layout, redesigned trigger circuit...assure easier operation,
- Advanced mechanical design gives:
  - Better cooling for longer component life,
  - Far greater accessibility for maintenance,
  - Increased ruggedness; resistance to vibration,
- Built-in single-sweep circuit ("1-shot" trigger) at no extra cost,
- Available for either 110 v. or 220 v. operation.

applications

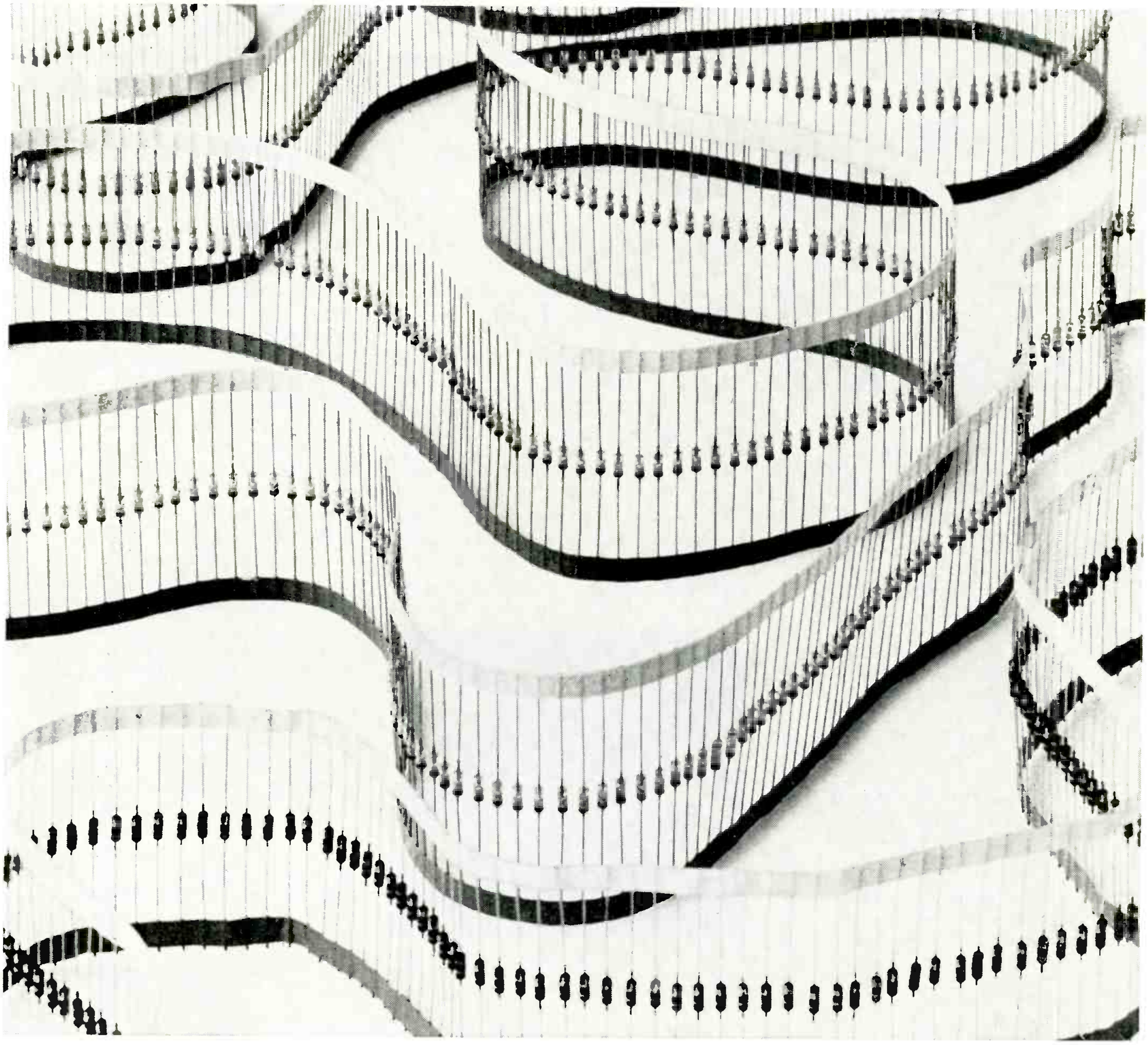
- Data reduction equipment trouble-shooting
- Physical testing: shock, stress, strain
- Ultrasonic flaw detection
- Semiconductor testing
- Ballistics and explosives research ...and many others.

INDUSTRIAL SYSTEMS DIVISION

HUGHES PRODUCTS

For complete information on the new improved Hughes "Memo-Scope" oscilloscope (Model 104E), detailed data sheets and application analysis of your transient measurement problems, write or wire: HUGHES PRODUCTS Industrial Systems Division, International Airport Station, Los Angeles 45, California

SEMICONDUCTOR DEVICES • STORAGE TUBES AND DEVICES • MICROWAVE TUBES • VACUUM TUBES AND COMPONENTS • CRYSTAL FILTERS • MEMO-SCOPE® OSCILLOSCOPES • INDUSTRIAL CONTROL SYSTEMS



ZENER DIODES IN A PROVEN GLASS PACKAGE

Now you can get high-performance voltage-regulator diodes in the famous, hermetically-sealed Hughes glass envelope. These diodes have an outstanding characteristic: sharp regulation of reverse voltage. This means that you can use them—with confidence—in clipping, clamping, coupling, and compensation circuits to obtain *dependable voltage regulation*. In addition, they retain this stability, together with low dynamic resistance, throughout a wide range of operating temperatures.

CHARACTERISTICS:
Nominal Voltage: 2 volts to 30 volts
Power Dissipation: 250 milliwatts
Maximum Dynamic Resistance: 10 to 75 ohms
Operating Temperature Range: −65° to 175° C.
Dimensions, Diode Glass Body: Maximum Length: 0.265″ max.
Maximum Diameter: 0.105″ max.

Standard types 1N702 through 1N720 available for immediate delivery from stock.

To obtain your copy of specifications covering the family of more than a dozen types of Hughes Silicon Voltage-Regulator Diodes, please write: Hughes Products, Semiconductor Division, Marketing Department, P.O. Box 278, Newport Beach, California.

SEMICONDUCTOR DIVISION

Creating a new world with ELECTRONICS

HUGHES PRODUCTS

SEMICONDUCTOR DEVICES • STORAGE TUBES AND DEVICES • MICROWAVE TUBES • VACUUM TUBES AND COMPONENTS • CRYSTAL FILTERS • MEMO-SCOPE® OSCILLOSCOPES • INDUSTRIAL CONTROL SYSTEMS

COMING EVENTS

A listing of meetings, conferences, and shows during December that are of special interest to electronic engineers. For a complete listing for the year 1960 see the "Coming Events" calendar beginning on page 151.

Dec. 1-2: 4th Midwest Symposium on Circuit Theory, Marquette University, Milwaukee, Wis.

Dec. 1-3: Eastern Joint Computer Conference, IRE (PGEC), AIEE, ACM; Hotel Statler Hilton, Boston, Mass.

Dec. 2-4: Electric Furnace Conference, Metallurgical Society of AIME; Cleveland Hotel, Cleveland, Ohio.

Dec. 3-4: 3rd Annual International Visual Communications Congress, Society of Reproduction Engineers; Statler Hilton Hotel, New York, N. Y.

Dec. 3-4: Annual Meeting, IRE Professional Group on Vehicular Communications; St. Petersburg, Fla.

Dec. 7-9: Meeting, American Management Association; Ambassador Hotel, Los Angeles, Calif.

Dec. 8-10: National Conference on Application of Electrical Insulation; AIEE, NEMA; Shoreham Hotel, Washington, D. C.

Dec. 13-16: Annual Meeting, The Material Handling Institute, Inc.; Savoy-Hilton Hotel, New York, N. Y.

Dec. 17: Wright Brothers Lecture, Institute of the Aeronautical Sciences, Natural History Building Auditorium, Smithsonian Institute, Washington, D. C.

Abbreviations

ACM: Association for Computing Machinery
AIEE: American Institute of Electrical Engineers
AIME: American Institute of Metallurgical Engineers
IRE: Institute of Radio Engineers
NEMA: National Electrical Manufacturer's Association
PGEC: Professional Group on Electronic Computers of the Institute of Radio Engineers

As We Go To Press . . .

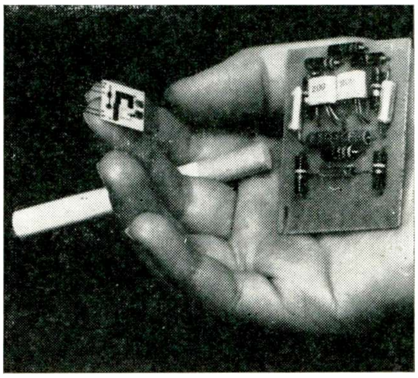
(Continued)

Miniaturization Wins Scientists $25,000

Five Army scientists, whose breakthrough in miniaturization made it possible to pack five times more electronic gear into missile nose cones, were given a $25,000 award.

The Army science team from Diamond Ordnance Fuze Laboratory in Washington, D. C., made the breakthrough by combining new techniques in photography and lithography with existing printed circuit techniques.

The process is similar to the photolithographic technique used in making offset (or lithograph) printing plates. A photographic process is used to create a pattern



Miniaturized module makes it possible to pack five times more electronic gear in the nose cones of missiles.

of circuitry and components on a plastic base wafer. The image is then developed by exposure to a special light to complete the process.

A series of these wafers can be stacked together to form a desired unit, or module, complete with circuitry. Due to extreme miniaturization the work must be done microscopically.

This new process lends itself readily to automated production and has opened the door to greater advances in the field of microcircuitry and solid state devices such as transistors.

The Army science team has turned over the patent rights to the government and they are now in the public domain.

The Army scientists who will receive $5,000 each are: Thomas A. Prugh, Mrs. Edith M. Olson, Norman J. Doctor, James R. Nall, and Dr. Jay W. Lathrop.

Plan AMC Electronics Center in New England

A change in the organizational structure of the Air Materiel Command was announced.

The change involves establishment of an Electronic Systems Center at L. G. Hanscom Field, Massachusetts. A limited number of personnel engaged in managing the acquisition and delivery of large complex ground electronic systems will move from Wright-Patterson Air Force Base, Ohio; Griffiss Air Force Base, New York and New York City to the new location.

Gen. S. E. Anderson, AMC Commander, in announcing the move which will take place during the next eight months, emphasized that: The objectives of this relocation are to establish in one location, under one commander, an organization responsible for the acquisition and delivery of large complex ground electronic systems, and for managing the AMC functional elements involved in these programs.

The new center will report directly to the Commander, Air Materiel Command, in the same manner as an Air Materiel Area Commander.

Low Freq. Standards

(*Continued from page 7*)

six lecture sessions, five workshop sessions on calibration procedures, and a question-and-answer program-evaluation and future-trends session.

Overall planning and coordination of the meeting was under the supervision of W. R. Thurston. Members of the G-R engineering staff who have participated in planning the technical program include D. H. Chute, I. G. Easton, H. P. Hall, J. T. Hersh, P. K. McElroy and R. A. Soderman. Among those who served as workshop instructors: R. A. Boole, D. H. Chute, J. F. Eberle and C. L. Woodford. Registration and arrangements chairmen J. C. Gray and L. W. Gorton, respectively.

Owing to the specialized nature of the seminar, attendance being restricted to invited guests only and limited in number to insure maximum effectiveness.

RELIABILITY
IN THE PALM
OF YOUR HAND...

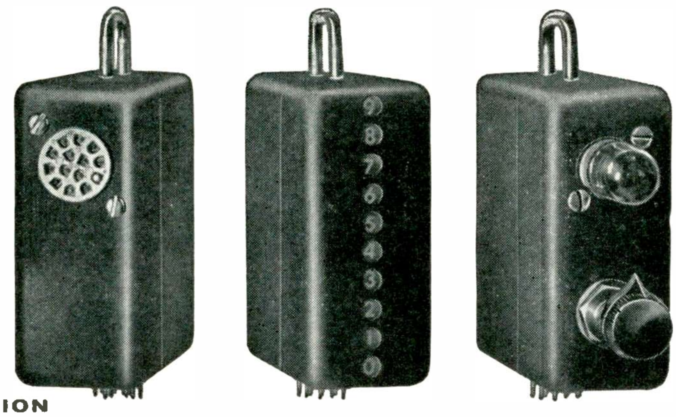
NEW

EECO N-Series
Transistorized
DECADES

for extremely reliable pulse-counting and frequency-division applications in the frequency range of 0 to 250,000 pulses per second.

FEATURES

The new EECO N-Series miniaturized and transistorized plug-in decimal counters feature simple power-supply requirements, low power consumption, small size, and extreme reliability. Saturation techniques, along with consistent derating of component tolerances result in a group of Transistorized Decades that will work dependably from 0 - 250 kcs even under adverse conditions of environment and power supply variations. All units are completely compatible with EECO T-Series Germanium plug-in circuits. In addition, an auxiliary 9-step staircase output is available. Most units are designed to plug into a special 13-pin miniature tube socket; other units plug into a standard 29-pin socket (Continental No. MM-29-22S). Mating socket is furnished with each decade.



ONE-HALF ACTUAL SIZE

WIDE SELECTION

EECO N-Series plug-in Transistorized Decades are available in a wide range of models. The counting circuitry is standardized for the various models. Provisions for visual readout and/or preset controls are as follows:

MODEL	DESCRIPTION
N-101	No readout.
N-102	Incandescent readout.
N-104	Incandescent readout (remote). Typically a projection readout module.
N-105	Nixie readout. (Can be cabled to remote Nixie.)
N-106	Nixie readout with preset control switch. (Can be cabled to remote Nixie.)
N-107	Incandescent readout with inputs for external preset control.
N-108	Incandescent readout (remote) with inputs for external preset control.
N-111	No readout, but with 1-2-4-2 code.

TYPICAL SPECIFICATIONS

The N-102 Transistorized Decade (with Internal incandescent readout) employs four binary stages operating in a 1-2-4-2 code. Visual readout consists of the numerals 0 through 9 displayed vertically and illuminated by incandescent lamps. Total power consumption is approximately one watt. Outputs include (N/10), (N/10)′, and a 9-step staircase, which may be adapted for a visual display by means of an emitter follower and DC voltmeter.

ELECTRICAL SPECIFICATIONS

INPUT
- Minimum Trigger Input: (0-100 kcs): 7 volts positive pulse or step at 0.5 μsec. rise time; (100 kcs to 250 kcs): 7 volts positive pulse or step at 0.2 μsec. rise time.
- Maximum Operating Frequency: 250 kcs.
- Input Impedance: 470 μμfd. capacitance, max.
- DC Reset Input is provided (normally supplied by T-129 DC Reset Generator).

OUTPUT (No Load)
- Amplitude: 8 volts, peak to peak.
- Output Levels: (N/10) and (N/10)′: —11 volts DC and —3 volts DC, nom. Staircase: —11 volts DC to —3 volts DC in 9 steps.
- Rise Time: (N/10): 0.5 μsec.; (N/10)′: 0.5 μsec.
- Type: (N/10), (N/10)′, and 9-step staircase.
- Load: Typical, two N-Series decades or two T-Series flip-flops. (Load information available on request.)

PHYSICAL SPECIFICATIONS

- Dimensions: 1-5/16″ wide x 3″ deep x 3-7/8″ seated height (including handle) Dimensions are exclusive of external addenda found in external preset and Nixie models.
- Mounting: Plugs into standard 9-pin miniature socket. (Some other models require a special 13-pin miniature socket, which is furnished with each such unit.)
- Pin Connections: Arranged for in-line wiring of power and grounds.
- Operating Temperature Range: —54°C to +71°C.

NOTE: 0 to 5 megacycle models available soon.

Additional information on N-Series Transistorized Decades and other EECO products available on request.

ENGINEERED ELECTRONICS Company

ENGINEERED ELECTRONICS COMPANY
(a subsidiary of Electronic Engineering Company of California)
506 East First Street • Santa Ana, California

INHERENT STABILITY
Assured in a DALOHM MC Resistor

The freezing temperature of coils is mild by comparison with the temperature extremes at which Dalohm resistors can operate reliably.

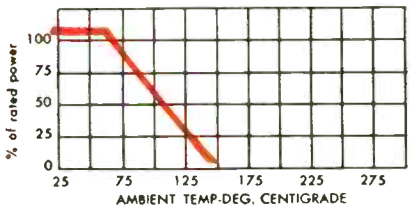
Stored on the shelf for months . . . or placed under continuous load . . . operating in severe environmental, shock, vibration and humidity conditions . . . Dalohm precision resistors retain their stability because it has been "firmly infixed" by Dalohm design and methods of manufacture.

For all applications demanding resistors that meet or surpass MIL specifications, you can depend on Dalohm.

DEPOSITED CARBON • MOLDED • MINIATURE
DALOHM **TYPE MC** RESISTORS

Made of pure crystalline carbon film with no binder or filler, these resistors offer excellent high frequency characteristics.

TYPICAL DERATING CURVE



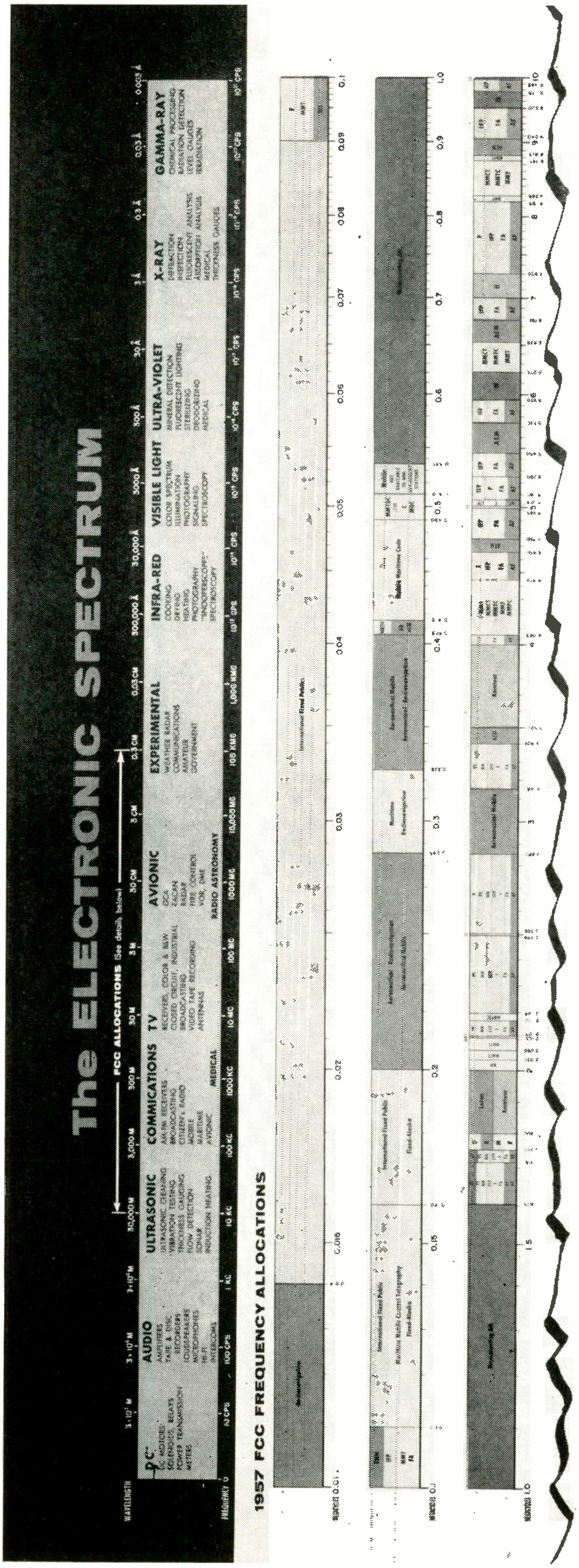
- **Rated at** 2, 1, ½, ¼ and ⅛ watts
- **Resistance range** from 10 ohms to 50 megohms, depending on type
- **Standard tolerance** ± 1%
- **Temperature coefficient** 500 P.P.M. maximum
- **Smallest in size,** ranging from 9/64″ x 13/32″ to ⅜″ x 2¼″
- **Full load operation** to 70° C., derating to 0 at 150° C.
- High heat dissipation
- Meet applicable paragraphs of MIL-R-10509B.

Write for Bulletin R-35, with handy cross-reference file card.

SPECIAL PROBLEMS?

You can depend on Dalohm, too, for help in solving any special problem in the realm of development, engineering, design and production. Chances are you can find the answer in our standard line of precision resistors (wire wound, metal film and deposited carbon); trimmer potentiometers; resistor networks; collet-fitting knobs; and hysteresis motors. If not, just outline your specific situation.

from **DALOHM**
Better things in smaller packages
DALE PRODUCTS, INC.
1304 28th Ave., Columbus, Nebr.



THE ELECTROMAGNETIC SPECTRUM—1960

History:

Many will remember the Electronic Spectrum Chart issued last in 1957. This four-page chart measuring approximately 15 x 22 in. presently adorns the walls of many electronic manufacturers, research and development laboratories, educational establishments etc. both here in the United States and abroad. (Note black-and-white replica at left). First issued by Electronic Industries in 1943 this chart has been periodically brought up to date to reflect changes in electronic services and frequency allocations. In recent years it has been re-issued on a two-year cycle basis. The 1957 issue went completely out of print in mid-1959 and since then EI editors have been busily correcting and up-dating a brand new chart which is now going on press.

The New Electromagnetic Spectrum Chart©:

- Goes into circulation on or about December 28, 1959
- Twice the size of previous charts—approximately 30 x 22 in.
- Printed to show service and frequency areas in six colors
- Suitable for framing and wall mount or,
- Under glass desk-top reference.

Prices:

Individual copies mailed in tubes	$1.00 each
1 to 25 copies	$1.00 per copy
26 to 100 copies	$0.75 per copy
More than 100 copies	$0.50 per copy

Orders filled on first-come-first-served basis. Press run is limited. More than 1,000 readers have already requested this edition. Please make remittances payable to Electronic Industries and mail to Reader Service Department, Electronic Industries, Chestnut & 56th Streets, Philadelphia 39, Pa.

Electronic Industries' News Briefs

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

EAST

LEESONA CORP. is the new name for Universal Winding Co., Providence, R. I. The corporation name was changed at a meeting of the common stockholders.

RADIATION INC., has received a contract for $400,000 for a highly advanced PCM Data Acquisition System from Norair, a division of Northrop Corp.

FXR, INC., Woodside, N. Y., has received $1½ million from Sperry Gyroscope Co. of Lake Success, N. Y. for the manufacture of additional dc line type modulators. The modulators were designed originally by FXR as a component of Radar Set AN/FPS-35.

CLIFTON PRECISION PRODUCTS CO., INC., Clifton Heights, Pa., manufacturer of precision synchros and synchro computing systems, has broken ground for an addition to its main plant in Clifton Heights. The new addition will increase their floor space by 40%.

RAYTHEON CO. has been awarded contracts totaling $38.9 million to produce search and Doppler radars for bombing-navigational systems of the Air Force's B58 Hustler bombers. The award was made by Sperry Gyroscope Co.

SYLVANIA ELECTRIC PRODUCTS INC., has received a $15 million contract for development of high-precision weapons-locating radar equipment for the U. S. Army Signal Corps. The equipment is designated type AN/MPQ-32.

KEARFOTT CO., INC., a subsidiary of General Precision Equipment Corp., has announced receipt of initial funding in the form of two letter contracts totaling $1,242,000 from the Air Force's Aeronautical Systems Center, Air Materiel Command for a product improvement program on the True Heading Computer group comprised of the AJA-1 True Heading Computer and the N1 Directional Gyro Compass System.

ALLEN B. DU MONT LABS., INC., has sold its 485,000 sq. ft. plant in East Paterson, N. J. to Curtiss-Wright Corp. for use by its Electronic Div.

DAYSTROM INC., Murray Hill, N. J., has announced that they have joined with Nichemen & Co., Ltd., one of Japan's oldest trading companies, in establishing a new Japanese firm to be known as Daystrom-Nichemen, KK.

BENDIX AVIATION CORP., International Div., has received a contract totaling nearly a million dollars to equip aircraft of the West German Air Force with a combined navigation and instrument landing system and spare parts.

MELPAR, INC., Falls Church, Va., is sponsoring 17 in-plant engineering and mathematics courses this fall semester in conjunction with 4 leading Washington and Northern Virginia educational institutions. Courses are available to all full-time employees.

BULOVA RESEARCH & DEVELOPMENT LABS., INC., has been awarded a contract by the Army Ballistic Missile Agency, Huntsville, Ala., for the design of a new subminiature control attenuation timer as part of a subminiaturization program for developing telemetering equipment needed to evaluate test firings of new rockets and missiles.

QUAN-TECH LABS., presently located in Morristown, N. J., will lease a new plant at 60 Parsippany Blvd., Parsippany, N. J., as part of an overall plan to increase research and production facilities.

F. J. STOKES CORP., Philadelphia, Pa., has let contracts for a 50,000 sq. ft. addition to its present plant at 5500 Tabor Rd. in Northeastern Philadelphia.

REPUBLIC ELECTRONICS INDUSTRIES CORP., Farmingdale, N. Y., has formed a new division to specialize in development, design and manufacture of aero-space instrumentation. The newly created Bio-Dynamics Div. will have its headquarters at the company's plant in Farmingdale.

TENNEY ENGINEERING, INC., Union, N. J., has just acquired an 11-acre tract at Wilmington, N. C., for its third plant.

THE SINGER MFG. CO., Singer Military Products Div., has just received a $1 million dollar Bureau of Aeronautics contract for the manufacture of AN/ASR-3 submarine detecting sets. Equipment is planned for use in several types of Navy ASW aircraft.

UNITED AIRCRAFT CORP., Hamilton Standard Div., has announced that a major renovation of all their buildings located in Broad Brook, Conn., and occupied by the electronics department is now under way.

HAGEN CHEMICALS & CONTROLS, INC., Pittsburgh, now has a new line of solid state, electronic PowrMag Controls containing no tubes, slide wires, or transistors. They claim it has almost universal application to all industrial process controls.

MID-WEST

DELCO RADIO DIV., General Motors Corp., will construct an ultra-modern 125,000 sq. ft. engineering building in Kokomo, Ind. The building will house some 300 engineering personnel in both the research and development of semiconductors and in radio and electronic engineering.

GENERAL MILLS, INC., has acquired the business and assets of Magnaflux Corp. of Chicago, Ill., pioneer in the development of techniques and equipment for detecting hidden flaws in industrial materials.

VICKERS INC., Electric Products Div., has announced price reductions on a new high-volume line of photoelectric cells. Low cost manufacturing techniques have permitted large-quantity prices to be reduced as much as 80% without sacrificing quality.

MISSOURI RESEARCH LABS., INC., have received a $700,000 U. S. Navy contract to manufacture, in quantity, a highly technical electronic device which provides a scientific means of testing the operating accuracy of radar equipment used by the Navy.

FEDERAL TOOL AND MFG. CO., Minneapolis, Minn., have eliminated the risks involved in tooling for new electronic and industrial equipment by the use of their rapid-phase tooling and production methods. Methods are said to provide an opportunity to test both market potential and new product design before setting up expensive permanent tooling.

FORD FOUNDATION has granted the University of Michigan $1,175,000 for science and engineering. This is one of the first of the new grants to be made.

A. O. SMITH CORP., Milwaukee, Wis., has purchased the Crowley Div. of the Aerovox Corp. at West Orange, N. J. Crowley manufactures ferrite components, permanent magnets, and powdered iron cores for the electronic industry.

WEST

TELECOMPUTING CORP. of Los Angeles, has been awarded new contracts totaling $1,608,000 by the Western Electric Co. for production of gyro systems for the Nike-Hercules ground-to-air defense missile.

PACKARD BELL ELECTRONICS CORP. has been awarded a second contract approximating $1,250,000 from the U. S. Navy Bureau of Aeronautics for the production of the AN/APX-7 airborne radar recognition set.

HOFFMAN ELECTRONICS CORP. will develop and market a line of silicon transistors. They will be manufactured in their new 109,000 sq. ft. plant located in El Monte, Calif.

AMPEX CORP. has announced completion of their merger with Orr Industries, Inc.

ELECTRONIC RESEARCH CORP., Burbank, Calif., has a new Commercial Products Div. concerned with the manufacture, marketing and further development of several patented items, including a solder dispensing tool and a new hand pump.

CONSOLIDATED ELECTRODYNAMICS CORP., Electro Mechanical Instrument Div., has received a $352,000 contract from the Federal Aviation Agency for recording oscillographs that will be used in flight inspection of air navigation aids.

ELECTRONIC ENGINEERING CO. OF CALIF., Santa Ana, Calif., has received a $358,000 contract for range instrumentation work at the National Aviation Facilities Experimental Center, Atlantic City, N. J. The range is employed to test existing and future air navigation and traffic control systems for civil aeronautics use.

PARKER SEAL CO., Culver City, Calif., has just developed and improved a technique to manufacture their fastener seals in stainless steel as well as steel, aluminum and other non-ferrous metals.

THE GARRETT CORP.'S AiResearch Mfg. Div. of Los Angeles, has just celebrated its 20th anniversary. This division manufactures aircraft and missile components.

COLLINS RADIO CO. has developed a 12-oz. remote microphone that takes the place of as much as 45 lbs. of conventional amplifier, battery and cable equipment. It was designed for covering sporting events, spot newscasts and other fast moving, remote broadcasting situations.

PERKIN-ELMER CORP. is opening advanced research and development facilities in Los Angeles to serve Space and Defense Industries in 11 Western states.

LING-ALTEC ELECTRONICS, INC., Anaheim, Calif., has started a $600,000 expansion of their plant.

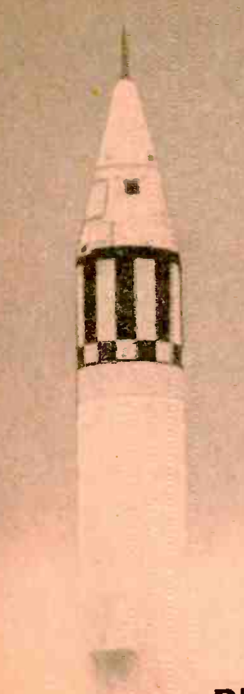
AEROJET - GENERAL CORP., Azusa, Calif., has received a contract from the Air Force Cambridge Research Center to design and fabricate 4 Astrobee-500 sounding rockets.

VARIAN ASSOCIATES, Palo Alto, Calif., have upped their master plan for the Stanford Industrial Park location from 500,000 to 1,000,000 sq. ft. Their rapid growth in the last few years has caused this sudden increase.

PACKARD BELL COMPUTER CORP. has received a contract from the U. S. Navy Electronics Lab., San Diego, to develop a high speed analog-to-digital conversion system.

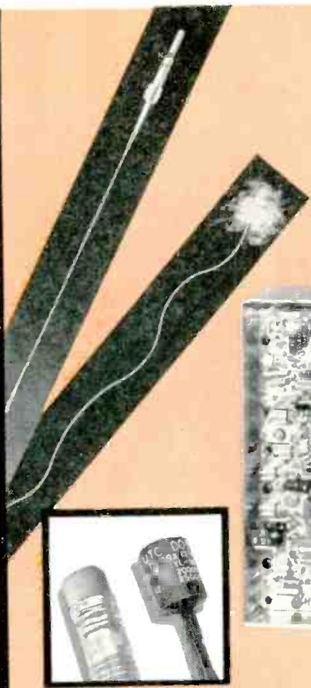
FIRST CHOICE FOR RELIABILITY

Designers of complex military and industrial equipment fully appreciate the need for extremely reliable components. For over a decade, UTC has been devoting constantly increasing manpower and dollars in the search for increased transformer and filter dependability. Investigation and analysis have been related to the life testing of large numbers of units to failure, plus thousands of wire-insulation-impregnant-potting and encapsulating systems. This program has resulted in proven materials, methods of structure and full quality controls which assure in UTC units an overall degree of reliability unequaled in our industry.



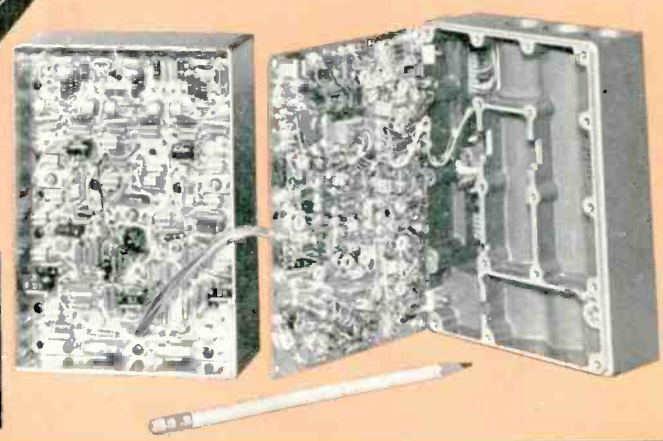
RELIABILITY UNDER ADVERSE ENVIRONMENT

As a leader in the production of extremely miniaturized components, UTC is a natural source for missile applications. Add to this the need for top reliability under adverse environmental conditions, and one can see why UTC units have been chosen for almost every missile from the Sidewinder to the Jupiter to the Atlas; our satellites, and project Mercury.



RELIABILITY TO DESTROY

A vital factor in second generation missiles is the sure ability to destroy the missile should something go wrong. UTC high reliability transformers were first choice for Ramo-Wooldridge in the design and production of their 4 pound AN/DRW-11 "command destruct" receiver which provides UHF FM signals to three command channels.



RELIABILITY TO NAVIGATE . . . CONTROL . . . COMMUNICATE

Manufacturers providing principal electronic gear for the B-58 chose UTC for optimum miniaturization with maximum reliability under adverse environment. In general aircraft use UTC high reliability units are found in virtually all applications such as Tacan, omnirange, intercommunication equipment, and fire control. The high inherent quality level of UTC airborne components is illustrated by over 19,000 units being shipped to one customer . . . then fully tested . . . with zero rejects.

Special Units to Your Specifications

or 1000 Stock Items . . . with UTC High Reliability

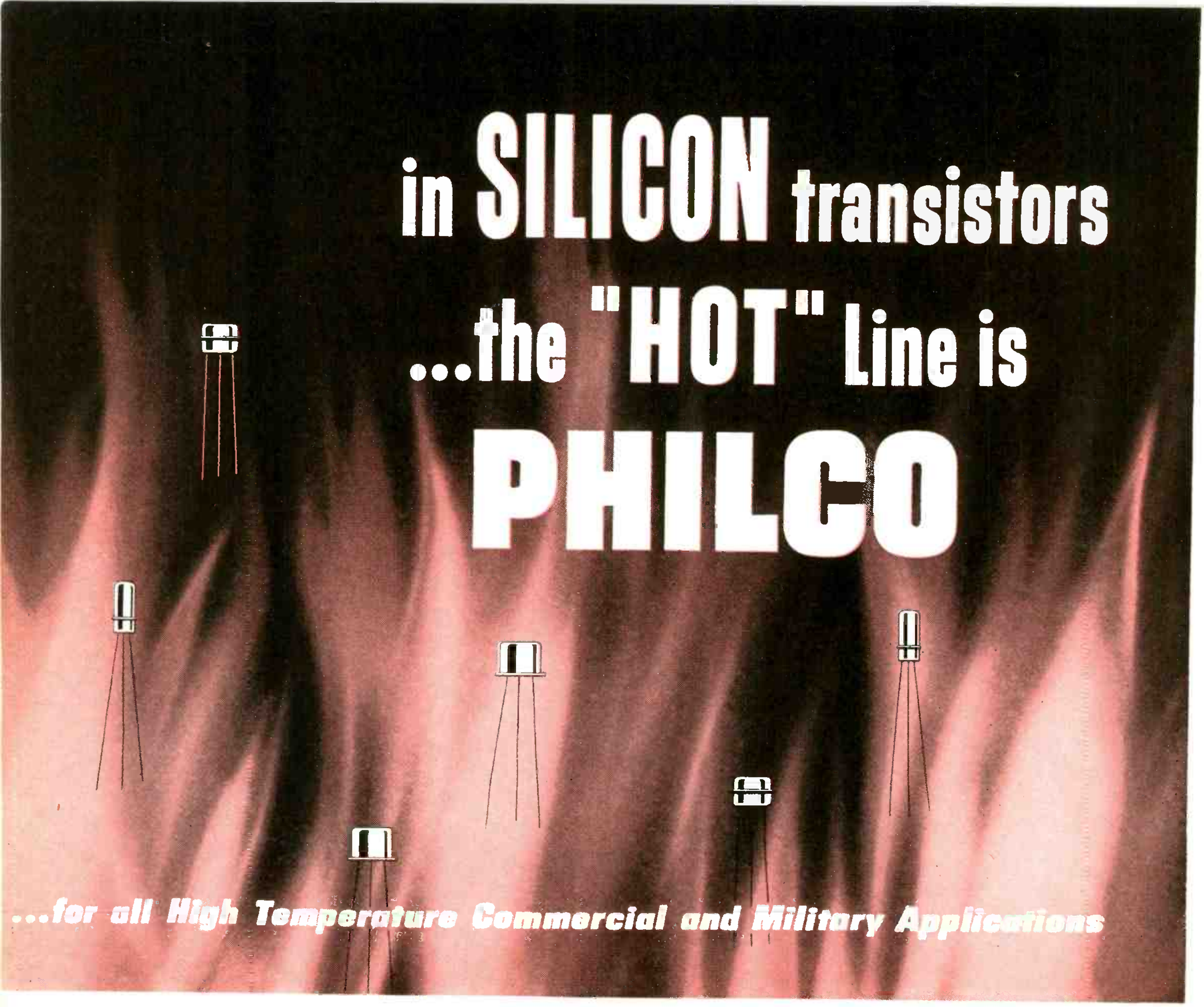
General Catalog G   Filter Catalog F

UNITED TRANSFORMER CORP.

150 Varick Street, New York 13, N. Y.

PACIFIC MFG. DIVISION: 4008 W. JEFFERSON BLVD., LOS ANGELES 16, CALIF.
EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y.   CABLES: "ARLAB"

Circle 8 on Inquiry Card



...High Speed Switches

Philco's full range of silicon high speed switching transistors, in both PNP and NPN types, provides the designer with a wide choice to meet the requirements of all high temperature applications. They are engineered and specified to permit simple, straightforward design of practical circuits up to 5 mc pulse rates, using saturated configurations and up to 30 mc pulse rates with non-saturating techniques. Packaged in TO-1, TO-5 and TO-9 cases.

PNP 2N496 2N1119 2N1429

NPN 2N1199

...High Frequency Amplifiers

Philco amplifying transistors are available in nine types, covering the complete high frequency range. The designer will find both PNP and NPN types that permit the design of communications systems at frequencies up to 60 mc. They have low collector capacitance and are available with restricted beta ranges to simplify design problems. All offer excellent performance at junction temperatures up to +140°C. Packaged in TO-1, TO-5 and TO-9 cases.

PNP 2N495 2N1118 2N1428

NPN 2N1267 2N1270 2N1268 2N1271 2N1269 2N1272

All types environmentally tested in accordance with MIL-T-19500A . . . and have been thoroughly field-proven in countless critical military and industrial applications. **For complete data and application information, write Dept. EI-1259**

All Types Immediately Available in Production Quantities . . . and 1-99 from your local Philco Industrial Semiconductor Distributor

PHILCO®

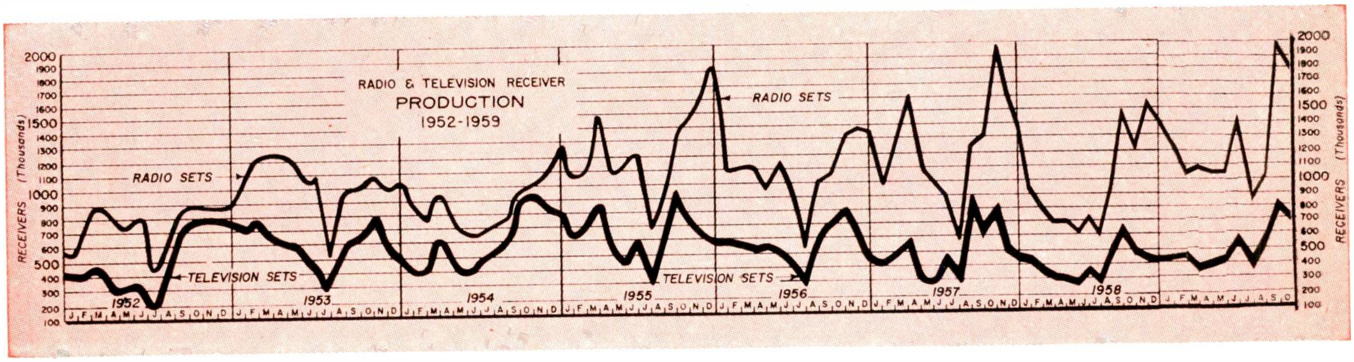
LANSDALE DIVISION • LANSDALE, PENNSYLVANIA

TRANSISTOR CENTER U.S.A.®

Circle 9 on Inquiry Card

Facts and Figures Round-Up December 1959

ELECTRONIC INDUSTRIES TOTALS



OUTPUT & SALES ARE UP

Cumulative receiving tube sales during the January-September period this year amounted to 315,797,000 tubes worth $269,128,000 compared with 291,718, 000 receiving tubes worth $252,590,000 sold during the like nine months period last year

Cumulative TV picture tube sales by manufacturers during the January-September period this year totaled 6,857,682 worth $132,465,278 compared with the 5,844,665 tubes worth $116, 232, 334 sold during the like nine months last year.

Year-to-date TV output totaled 4,488,857 compared with 3,572,189 TVs made during the like nine months last year.

Cumulative television sales at the retail level totaled 3,811,754 compared with 3,468,090 sold during the like nine months last year (January-September).

Radio output in September totaled 1,981,208, including 717,501 auto receivers, compared with 1,009,423 radios made in August which included 279,424 auto sets, and 1,492,668 radios made in September 1958 which included 489,739 auto receivers.

The number of FM radios made in September totaled 76,942 compared with 42,886 made in August and 41,408 made in September 1958. Cumulative FM radio output during the first nine months of this year totaled 367,804 compared with 176,061 such radio receivers made during the like three quarters last year.

Cumulative overall radio output during the January-September period totaled 10,927,252 including 4,151,846 auto receivers, compared with 7,686,197 radios made during the like 1958 period, which included 2,383,551 auto sets.

Radio receiver sales at retail in September amounted to 928,457, excluding auto sets, compared with 671,713 radios sold in August and 750,026 radios sold in September last year.

Year-to-date radio sales at retail totaled 5,285,878, excluding auto sets, compared with 4,556,545 radios sold at retail during the like nine months period last year.

—Electronic Industries Association

GOVERNMENT ELECTRONIC CONTRACT AWARDS

This list classifies and gives the value of electronic equipment selected from contracts awarded by government agencies in October, 1959.

Amplifiers	536,326
Amplifiers, synchro signal	84,864
Analyzer, spectrograph	87,000
Antennas & systems	621,778
Batteries, dry	2,487,355
Cable assemblies	291,592
Cable, electronic	116,533
Cable, telephone	163,681
Calibrators	52,630
Capacitors	48,419
Connectors	596,074
Crystal units	45,790
Filters	42,418
Generator, pulse	32,875
Handsets	222,128
Headsets	503,125
Indicators, frequency	619,734
Loudspeakers	176,873
Meters, volt	28,475
Networks, pulse forming	66,620
Oscillators	70,768
Oscilloscopes	204,120
Oscillographs	127,931
Radiac sets	45,879
Reactors	38,807
Receivers, radio	26,070
Recorder, video tape	409,000
Recorders/reproducers	122,046
Relay, armature	157,760
Relay assemblies	80,557
Relay, thermal	36,690
Resistors	41,876
Semiconductor devices	92,867
Switchboard equipment	555,870
Switches	194,980
Switch, pressure	60,900
Synchros	29,057
Tower, radar	199,779
Transformers	759,844
Transistors	29,924
Transmitters	34,055
Transceivers	32,185
Tubes, electron	3,315,941
Tubes, klystron	124,890
Waveguide assemblies	54,977
Wire	145,396

JAPANESE PRODUCTION

Japanese production of electronic items in the first quarter this year was at an annual rate of more than $736 million, or $238 million above the 1958 level, reported the Business and Defense Services Administration, US. Dept. of Commerce.

In a compilation of figures based on data from the American Embassy, Tokyo, the Electronics Division, BDSA, said that Japan's electronic output for January-March 1959 was $184.4 million, and that if this rate of activity is maintained, the 1959 totals will double the 1957 output of $362.2 million. The 1958 total was $498 million, ranking Japan as the fourth largest producer of electronic products, behind the United States, United Kingdom, and West Germany.

U.S. electronics production is running at an annual rate of approximately $8.5 billion.

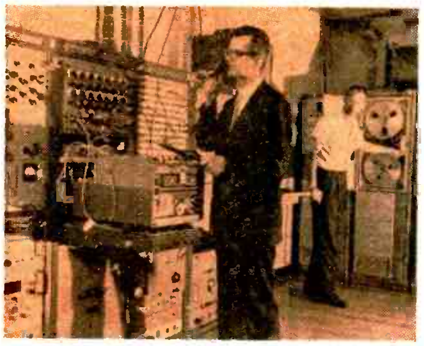
The greatest increase in volume in Japanese production between 1957 and 1958 occurred in consumer electronic products —from $170.9 millions to $266.2 million. In this category the largest increase was in the production of television receivers, from $86.8 million (0.6 million units) to $154.1 million (1.2 million units) followed by radio receivers, $67.0 million (3.6 milion units) to $87.1 million (4.9 million units). These values represent factory prices plus domestic excise taxes and royalties, if any. Excise taxes are 30 percent on television receivers with picture tubes of over 14" and 20 percent on those with picture tubes of 14" and less.

Semiconductor output registered the greatest rate of increase—129 percent—from $10.7 million in 1957 to $24.5 million in 1958; production during the first quarter 1959 amounted to $11.5 million. The principal item in this group is transistors, of which 5.7 million units valued at $8.9 million were produced in 1957; 26.7 million units at $21.4 million in 1958; and 15.0 million units at $9.9 million in the first quarter 1959.

ESTIMATED SHIPMENTS FOR FIRST HALF OF 1959

Category	Quantity in thousands of units			Value in millions of dollars		
	Total	Military	Nonmilitary	Total	Military	Nonmilitary
Receiving tubes	214,903	17,036	197,867	188.1	35.4	152.7
TV picture tubes	4,500	—	4,500	87.9	—	87.9
Power and special purpose tubes	5,751	1,702	4,049	124.7	87.5	37.2
Semiconductor devices	93,880	22,723	71,157	177.2	74.4	102.8
Capacitors	587.8	67.6	520.2	111.1	33.8	77.3
Connectors	41.4	26.6	14.8	69.8	49.1	20.7
Quartz crystals	1.8	0.7	1.1	5.1	2.0	3.1
Relays (for electronic applications)	11.7	4.5	7.2	85.2	45.1	40.1
Resistors	972.9	151.8	821.1	112.0	53.9	58.1
Transformers and reactors	11.2	3.2	8.0	68.0	38.2	29.8

—U. S. Department of Commerce



TELEPHONE LINK

Telephone lines transmit telemetered flight test data in 4 hours from Florida to Boeing in Seattle. Old method, airlifting, took days.

BOXCAR ANTENNA

This rotating 50-ton giant Super Sentry, 104 ft. long, will join the nation's SAGE defense net work in the near future. It is part of an 800 ton system which Raytheon started to develop in 1956.

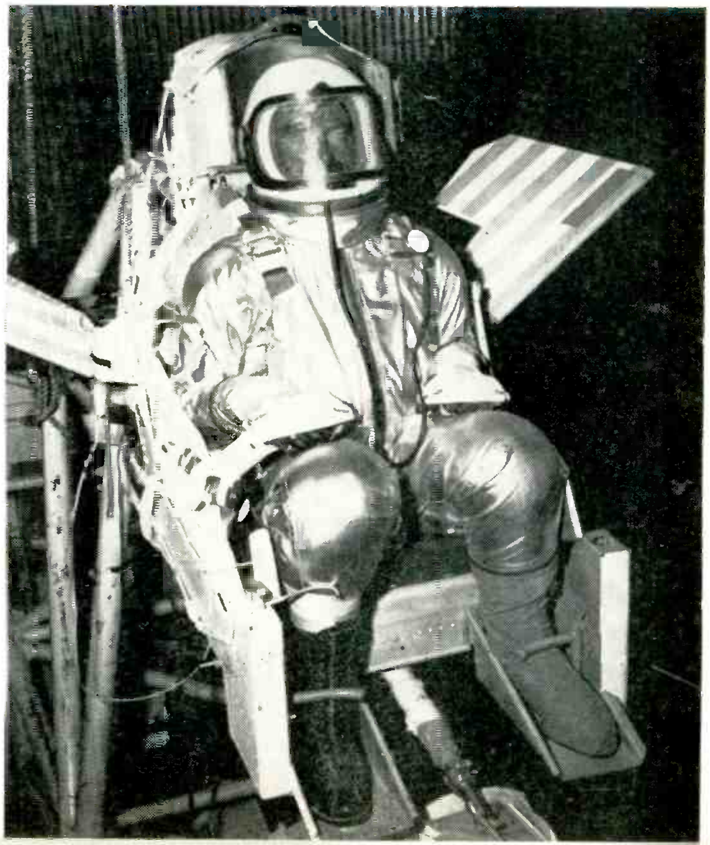
Snapshots . . . of

SECOND CHIN

The small chin on the McDonnell F4H-1 profile houses an infra-red detection system developed by Avion Div., ACF Industries.

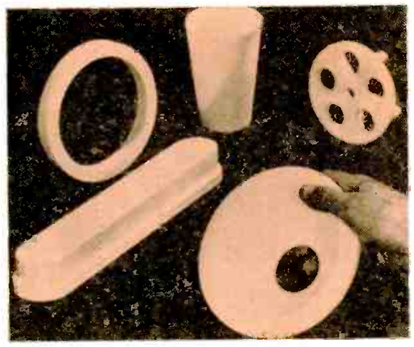
EJECTION WINGS

Aluminum honeycomb fins, jutting from the sides of the ejection seat will stabilize flight of ejected seat before chute opens. Made by Hexcel Products, Inc., the fins will eliminate the uncontrolled tumbling which previously caused serious injury.



TICKER TAPE & TV

Customers' room at Goodby & Co., stock brokers, features General Precision Lab ticker tape TV receiver, 1 of 15 owned by the firm.



FUSED SILICA

Corning's technique for producing high purity fused silica has aroused missile industry. Material softens at 2900° F.

MULTI-BEAM ANTENNA

First land antenna to establish target position in 3 dimensions transmits several narrow beams. GE produces the AN/FPS-7.

LETTER SORTER

Electro - mechanical coding system activated by operator of Burroughs sorter drops letters into proper bins from conveyor.

PLEASANT JOB

Sales engineer for Daystrom-Weston explains features of plug-in circuitry recorder to pretty ISA Show visitor.

The Electronic Industries

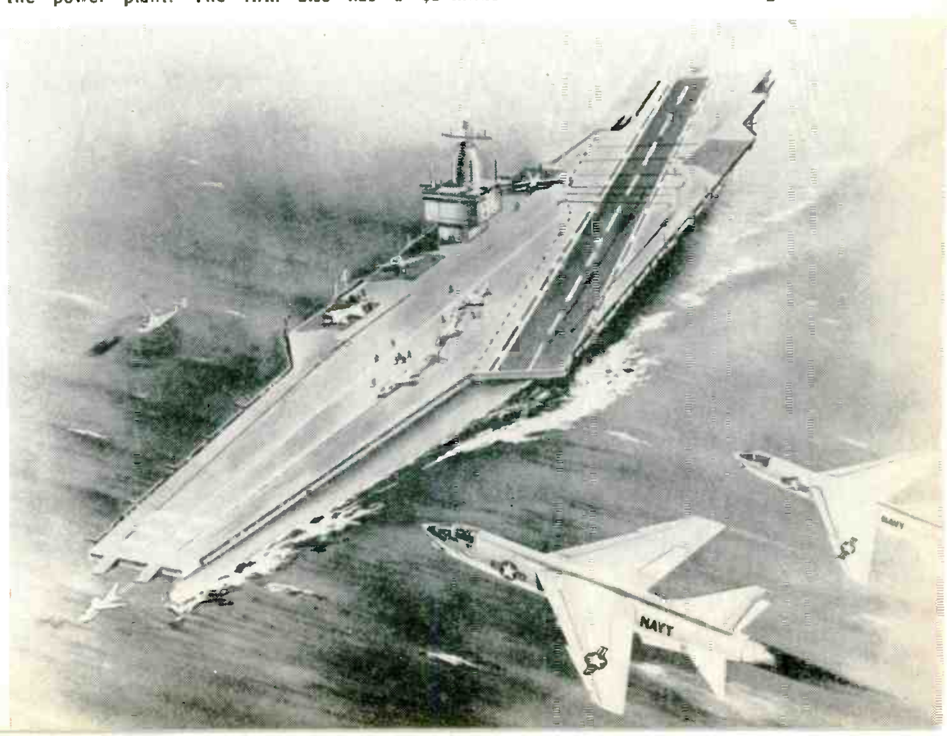
More Snapshots on page 119

DIODE TEST RECORDS

At Hoffman Semiconductor Div., Zener reference diodes are automatically tested at three environmental temperatures and the results at each are entered on paper tape.

NUCLEAR CARRIER

Artist's sketch of nuclear aircraft carrier, USS Enterprise, for which Westinghouse will supply the power plant. The firm also has a $3-million contract for 4 deck-edge elevators.



Largest selection

Trimpot®

the original leadscrew-actuated potentiometer

More engineers specify Trimpot because:

Trimpot line is complete

Bourns offers you the largest selection of leadscrew actuated potentiometers... 20 basic models—4 terminal types—three mounting methods.

Trimpot is small

Space saving size and rectangular shape permit the installation of 12 to 17 units in one square inch of panel area.

Trimpot is accurate

Multi-turn screwdriver adjustment provides 9000° of rotation . . . you can make and repeat the finest adjustments.

Trimpot is stable

Adjustment shaft is self-locking...settings are virtually immune to severe acceleration, vibration and shock.

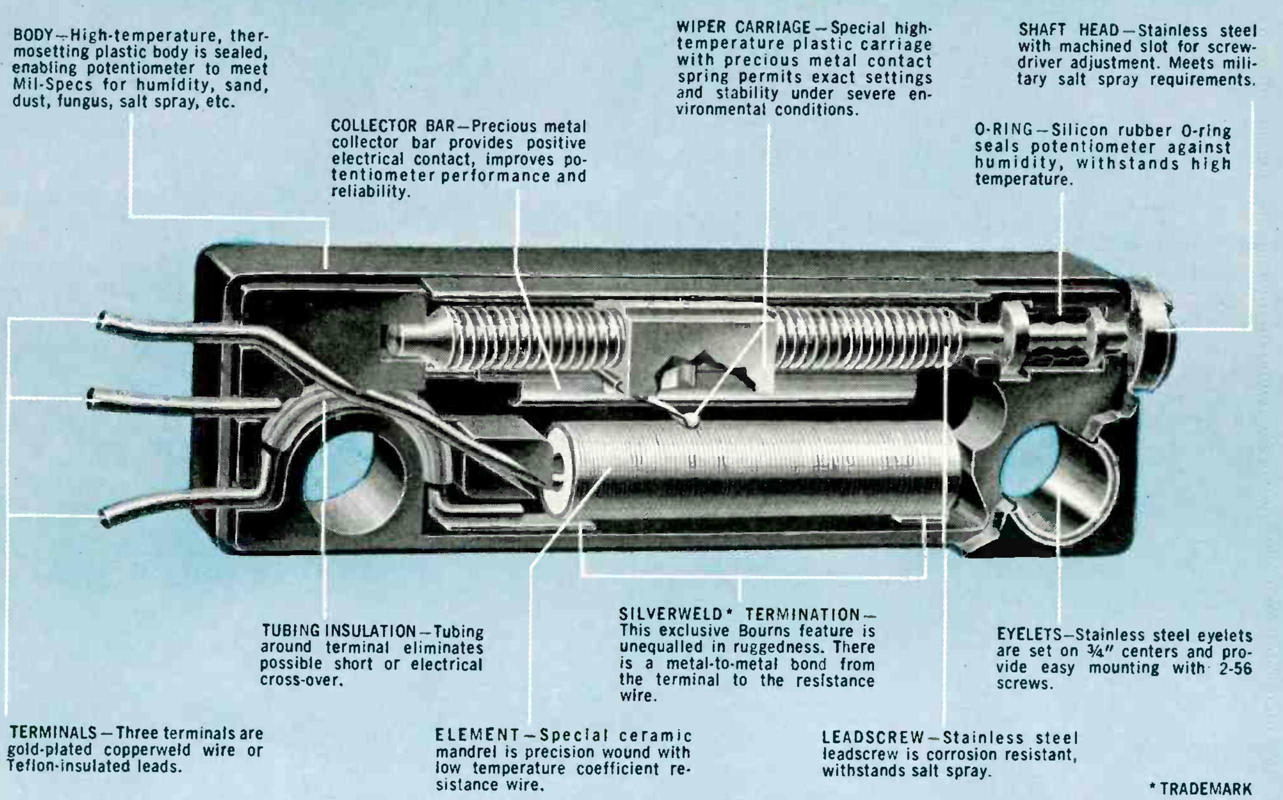
Trimpot is fully tested

All instruments are 100% inspected before shipment to assure you of reliable performance.

Trimpot is proved

It is used in more military and commercial equipment than any other leadscrew actuated potentiometer.

Only Bourns Trimpot potentiometers give you these outstanding features

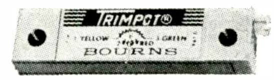


* TRADEMARK

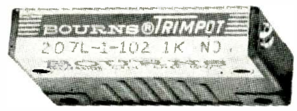
This cutaway of Model 220 is typical of the design of all Bourns Trimpot potentiometers though some features may vary from model to model.

Longest record of reliability

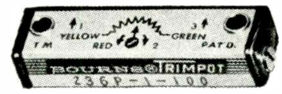
General Purpose Wirewound Trimpot—Model 200. Operates at 105°C / L,S,P terminals / 1/4 watt / 10 ohms to 100K. Available as rheostat, Model 201.



High-Temperature, Humidity-Proof Wirewound Trimpot—Model 224. Operates at 175°C / L,S,P terminals / 1 watt / 100 ohms to 100K. Meets Mil-Specs for humidity.

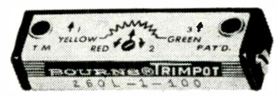


High-Resistance Wirewound Hi-R® Trimpot—Model 207. Operates at 175°C / L terminal / 2 watts / 100 ohms to 100K. Available as rheostat, Model 208 Hi-R Trim R®.



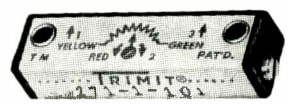
Humidity-Proof Wirewound Trimpot—Model 236. Operates at 135°C / L,S,P terminals / 0.8 watt / 10 ohms to 100K. Meets Mil-Specs for humidity.

Dual-Element Wirewound Twinpot®—Model 209. Operates at 105°C / L terminal / 1/4 watt / 10 ohms to 20K. Two potentiometer outputs with one adjustment shaft.



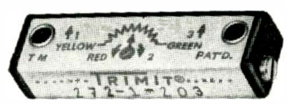
High-Temperature Wirewound Trimpot—Model 260. Operates at 175°C / L,S,P terminals / 1 watt / 10 ohms to 100K.

General-Purpose Carbon Trimpot—Model 215. Operates at 125°C / L,S,P terminals / 1/4 watt / 20K to 1 Meg. Available as Mil-Spec humidity-proof unit, Model 235 (1K to 10 Meg).

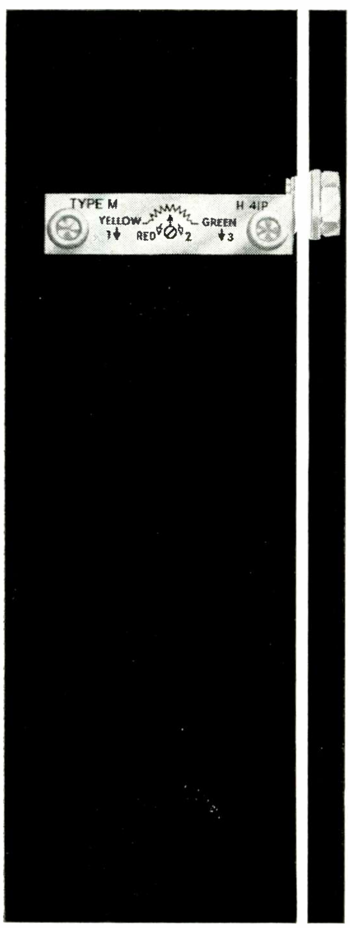


High-Quality Commercial Wirewound Trimit®—Models 271, 273, 275. Operates at 85°C / L,S,P terminals / 1/4 watt / 100 ohms to 10K.

Subminiature Wirewound Trimpot—Model 220. Operates at 175°C / L & W terminals / 1 watt / 100 ohms to 20K. Meets Mil-Specs for humidity.



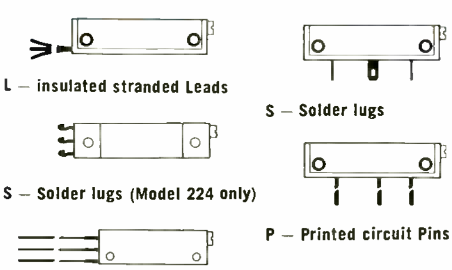
High-Quality Commercial Carbon Trimit—Models 272, 274, 276. Operates at 85°C / L,S,P terminals / 0.2 watt / 20K to 1 Meg.



Panel-Mount Trimpot

All models are now available with the added convenience of panel mounting. Unique design permits quick factory attachment of rugged panel-mount assembly to standard "on-the-shelf" Trimpot potentiometers. The Panel Mount Trimpot takes as little as 1/12 sq. inch of panel space, meets Mil-Specs for vibration, shock, salt spray, etc. Recessed head prevents accidental changes of setting. Silicon rubber O-ring and Teflon washer provide moisture barrier.

Key to terminals



L — insulated stranded Leads

S — Solder lugs

S — Solder lugs (Model 224 only)

P — Printed circuit Pins

W — uninsulated Wires

Standard resistances (ohms)

10	50	200	1K	5K	20K	100K	500K
20	100	500	2K	10K	50K	200K	1Meg

other Resistances Available

Write for detailed specifications and list of stocking distributors.

BOURNS Inc.

P.O. Box 2112P, Riverside, California

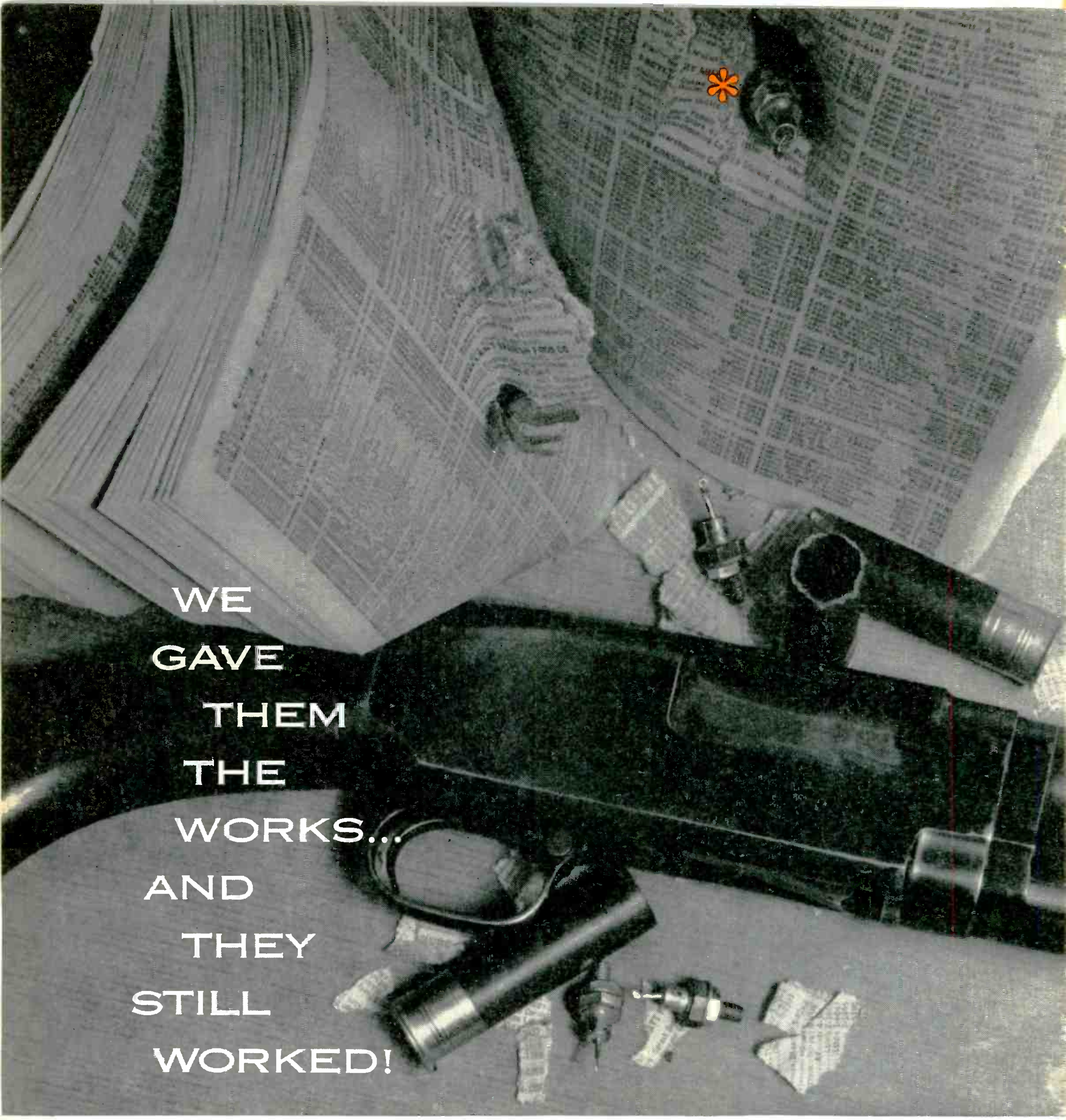
Plants: Riverside, California

and Ames, Iowa

In Canada: Douglas Randall (Canada), Ltd., licensee

Exclusive manufacturers of TRIMPOT®, TRIMIT®. Pioneers in potentiometer transducers for position, pressure and acceleration.

Circle 10 on Inquiry Card



After being blasted out of a shotgun into a telephone directory, these International Rectifiers tested out to published specifications. Shock-resistant ruggedness like this is just one distinguishing feature of the reliability you can depend upon when you specify any International Rectifier.

* *If you were wondering, they reached page 772 of the phone book. And if your curiosity about International Rectifiers goes even deeper than that, a note on your company letterhead will put you on our monthly Rectifier News mailing list.*

INTERNATIONAL RECTIFIER CORPORATION

EXECUTIVE OFFICES: EL SEGUNDO, CALIFORNIA • PHONE OREGON 8-6281

WORLD'S LARGEST SUPPLIER OF INDUSTRIAL METALLIC RECTIFIERS • SELENIUM • GERMANIUM • SILICON

OFFICES AND REPRESENTATIVES THROUGHOUT THE WORLD

Circle 11 on Inquiry Card

EI's International News

JAPAN

"Restrictions On Imports Could Hurt U. S. Trade"

The Electronic Industries Association has petitioned the Office of Civil and Defense Mobilization to investigate the growing volume of imports of Japanese electronic products. A result could be a revision of the U. S. trade agreements extension act.

Opposing any such revision, Dr. H. Imai, an official of Toshiba (Tokyo Shibaura Electric Co., Ltd.), said at the recent ISA Instrument-Automation Exhibition in Chicago, "Imports of Japanese electronic equipment are not a threat to U. S. national security and the growing strength of Japanese industry in this field is in reality an aid to America's defense." Said Dr. Imai, "restrictive change in trade agreements legislation may, in effect, have adverse reactions upon large segments of the U. S. electronic industry."

In support of his argument he said, "many (U.S.) companies use component parts from Japan in their assembly and manufacture of defense products. And many prominent American manufacturers are directly affiliated with large Japanese industries and, in fact, are substantial stockholders in these industries." He also cited the $17,000,000 sales of scientific and technical instruments by U. S. firms to Japan last year, and the greater dollar volume of total exports from the U. S. to Japan.

EUROPE

High Speed Computer for Swedish Defense

Sweden's new air defense system will use automatic electronic techniques to make it more effective than their previous systems. The heart of the new system is a high speed computer which solves a large number of interception problems simultaneously, and enables the defence weapons to be brought into action at precisely the right instant.

The initial contracts for the design and supply of the electronic equipment, approximately $420,000,000, have been awarded to Marconi's Wireless Telegraph Co. of England. In the Swedish Air Defense System, radar is used to detect and identify enemy raids giving full positional and height information, while automatic tracking methods are employed to render the system proof against disorganization by saturation attacks.

New Swiss Office

Arthur D. Little, Inc., U. S. research organization, is opening a new office in Zurich, Switzerland. Raymond Stevens, President of the Company, described the opening as one step in the company's international expansion program. Other company basic research offices are located in San Juan, Puerto Rico, and in Edinburgh, Scotland. Alexander Bogrow will head the new Zurich office.

DuMont Gets Radar Contract

The International Div., Allen B. DuMont Laboratories Inc., Clifton, N. J., has received a $331,000 contract from the Royal Danish Air Force for an improved version of DuMont's APS42 (the APS42B) radar sets. The radar sets will be used in Danish aircraft patroling the North Atlantic, Arctic Ocean, and the Denmark Strait between Greenland and Iceland.

Establish European Subsidiary

The establishment of Garrett International in Geneva, Switzerland, as a subsidiary company of The Garrett Corp., Los Angeles, has been announced. The new subsidiary is under the management of Bryan S. Clark, Director of Foreign Operation-Europe.

The Garrett Corporation also has a Canadian subsidiary, Garrett Manufacturing, Ltd., in Toronto, Ontario.

USSR

Communists Step-up Radio Propaganda

Communist radio output to the Near East, South Asia, and Africa rose 15% in the first six months of 1959, the U. S. Information Agency reports. In the past two years, communist broadcasting to this area has more than doubled—from 241 to 497 hrs. per week.

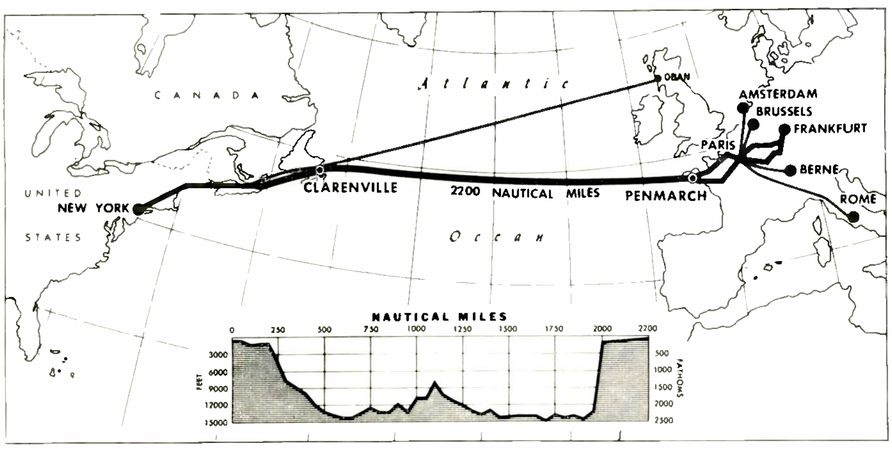
Total output, including satellite broadcasting, has reached an all-time high. Total USSR output remained at the same level during this period, but there were changes in area emphasis. Communist China expanded its efforts slightly, but indicates further substantial increases.

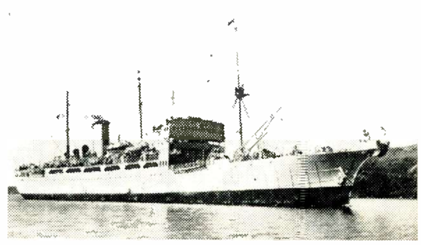
Other "highlights" of communist international broadcasting include: an expansion of broadcasts to Spain by the clandestine "Radio Espana Independiente" station; the appearance of a Persian language station; and increased use of quiz programs as communist propaganda media. The big prizes on the quiz shows were trips behind the Iron Curtain.

(*Continued on page* 32)

DIRECT CABLE LINK TO EUROPE

Route of first cable system to link the U. S. with continental Europe extends from Clarenville, Newfoundland to Penmarch, France. Two cables are provided—one for each direction. A single cable links Clarenville and Sydney Mines, Nova Scotia. A radio relay route link connects to Portland, Me., and Bell System's nationwide telephone net. Two cable routes link Penmarch to Paris for European distribution. Ship below is the Monarch, world's largest cableship, one of four vessels which laid cable across the ocean. Another ship, the Ocean Layer, caught fire during the cable laying operation.





Formica team:

(l to r) Eldon Fender, R&D; John Pitzer, Manager of Process Engineering; and Fenton Hamilton, Manager of Industrial Products—demonstrates flame retardant properties of new paper-epoxy grade.

Formica perfects new Flame Retardant grade

New EP-37 Properties . . .

- Flame retardant
- Self-extinguishing
- Dimensional stability under both solder dipping and humidity conditions
- Million megohms IR
- Cold punch 1/16″
- 10# avg. bond strength
- 500°F. solder heat resistance for 25 secs.

The team shown above demonstrates the flame retardant, self-extinguishing properties of the newest Formica® copper clad, EP-37. Because of these unusually effective properties, the new paper-epoxy is well suited for use in computers, radio, tv, telephone and aviation electrical devices. Increased dimensional stability—30% greater than existing grades under moisture conditions—offers many other application advantages.

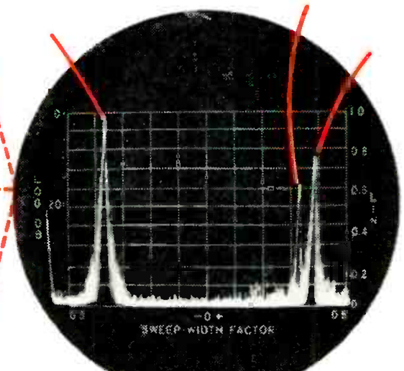
This basic new material offers the additional properties shown at left—so essential for dependable printed circuit performance. For complete information, send for free test sample and data information. Formica Corporation, a subsidiary of American Cyanamid, 4536 Spring Grove Ave., Cincinnati 32, Ohio.

FORMICA® Laminated Plastic

a product of CYANAMID

FI-2158

PANORAMIC PANADAPTORS give you continuous visual spectrum analysis of communications signals



Interference analysis with Model SA-8b Panadaptor. Sidebands from AM channel #3 is seen to spill into band occupied by intermittent CW channel #2.

- Detecting and investigating interference caused by splatter, harmonics, r.f. parasitics and multipath transmissions.
- Tuning aid for telemetry and SSB signals.
- Rapidly locating and identifying intermittent and irregular transmissions.
- Spotting inadvertent off-frequency transmissions.
- Band occupancy studies.

Operating in conjunction with a communications receiver, the Panadaptor automatically scans the band around the frequency to which the receiver is tuned. Scan is adjustable from full sweep width capacity for observivng over-all band to reduced sweep widths for detailed narrow band signal analysis.

Panoramic Panadaptors are available in two models and 14 types, to operate with RF, VHF, and UHF receivers having standard IFs. Also available are specially designed Panadaptors for use with receivers with non-standard IFs or other unusual properties.

PANORAMIC'S PANADAPTOR MODEL SA-8b is a professional-quality spectrum analyzer designed for convenience and exceptional versatility. Adjustable sweep width, sweep rate and IF bandwidth controls provide for optimum frequency resolution. Log, linear and power amplitude scales are precisely calibrated on a long persistence 5″ CRT.

PANORAMIC'S PANADAPTOR MODEL SA-3 is a rugged, compact, easy to operate unit with a 3″ CRT. Only three controls are needed—sweep width, gain and center frequency. Cabinet or rack mounting optional.

	Model SA-8b				Model SA-3									
	Type T-100	Type T-200	Type T-1000	Type T-10,000	Type T-50	Type T-100	Type T-200	Type T-1000	Type T-1000	Type T-2000TDI	Type T-2000NC	Type T-3000	Type T-3000CI	Type T-6000
For receivers with IF	455kc or 500kc	455kc	5.25mc	30mc	455kc	455kc or 500kc	455kc	5.25mc	10.2kc or 10.7kc	30mc	30mc	30mc	21.4mc	30mc
Sweep Width	0-100kc	0-200kc	0-1mc	0-10mc	0-50kc	0-100kc	0-200kc	0-1mc	0-1mc	0-2mc	0-2mc	0-3mc	0-3mc	0-6mc
Direct Sensitivity (*)	1000μv	2000μv	2000μv	150μv	200μv	200μv	200μv	200μv	200μv	500μv	10μv	1mv	50μv	10mv
Sweep Rate	Sweep may be synch'd externally or to power line or free running.				30 sweeps per second, line synchronized. (25 sweeps/sec with 50-cps power line.)									
Amplitude Scales	Linear (calibrated from 0 to 1.0). Logarithmic (from 0 db to —40 db). Power.				Nominally linear									
Resolution Capabilities. Depends upon sweep rate and sweep width	50cps to 4kc Variable	50cps to 4kc Variable	200cps to 10kc Variable	9kc to 80kc Variable	At maximum sweep width: 2.5kc	3.4kc	4.4kc	11kc	11kc	20kc	20kc	25kc	25kc	50kc
					Approximately 20% improvement at 20% of full sweep width.									

* Direct sensitivity (Model SA-8b) is the maximum voltage at the center frequency required for a full scale deflection on the linear amplitude scale. Direct sensitivity (Model SA-3) is the maximum voltage at the center frequency required for ¼ inch deflection.

Panadaptors are available for most receivers. For best over-all response, the receiver type should be mentioned when inquiring about Panadaptors.

Write today for detailed specifications bulletin. Also send for new Catalog Digest and ask to be put on the regular mailing list for The Panoramic Analyzer, featuring application data.

Panoramic RADIO PRODUCTS, INC.

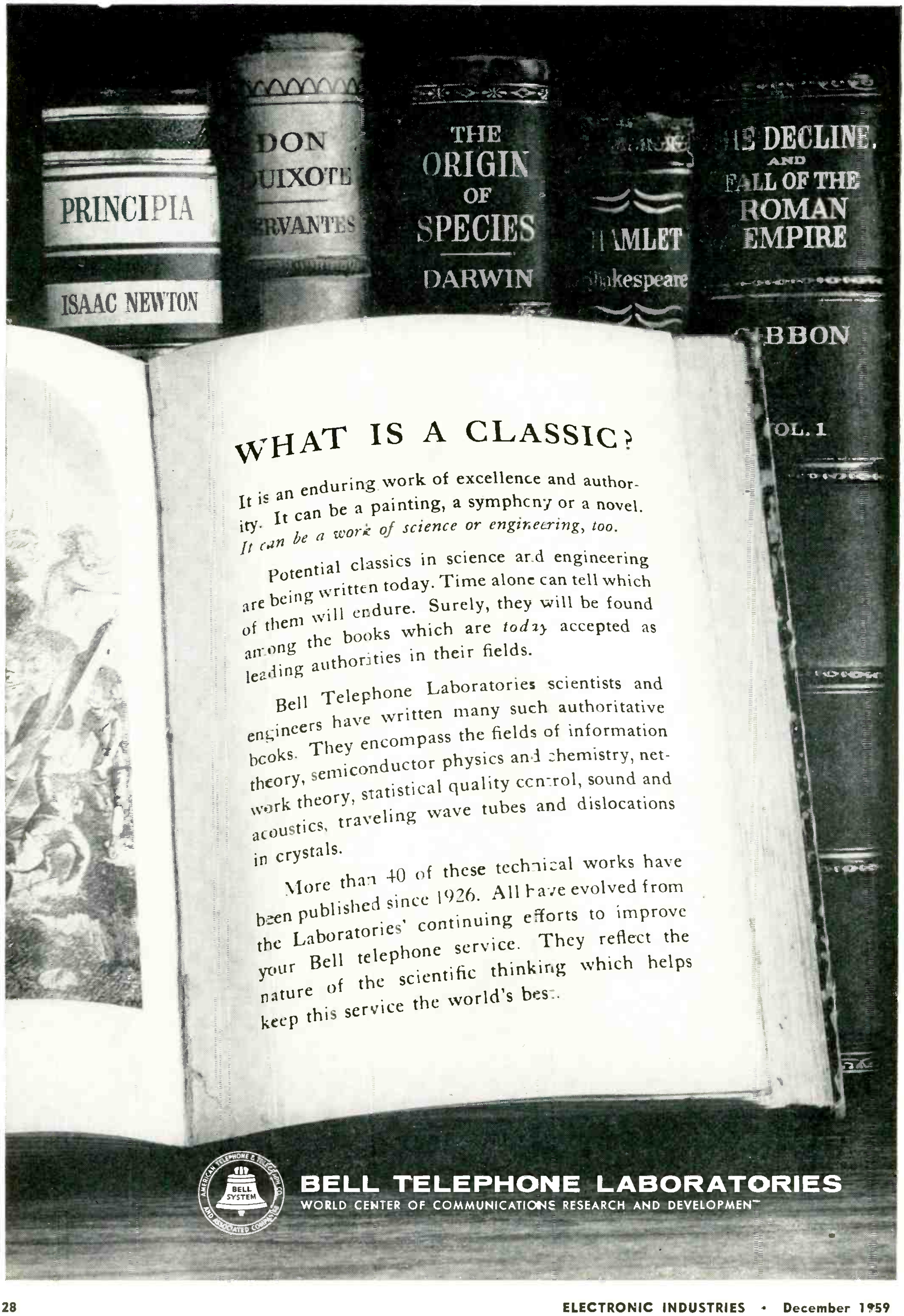
the pioneer is the leader

WE CATALOG IN eem electronic engineers master

dependable CERTIFIED SPECIFICATIONS for accurate data

PANORAMIC RADIO PRODUCTS, INC.
540 South Fulton Avenue, Mount Vernon, N.Y. • Phone: OWens 9-4600 • Cable: Panoramic, Mount Vernon, New York State

Circle 13 on Inquiry Card


PRINCIPIA
ISAAC NEWTON
DON
THE
ORIGIN
OF
SPECIES
DARWIN
AND
ROMAN
EMPIRE
WHAT IS A CLASSIC?
It is an enduring work of excellence and authority. It can be a painting, a symphony or a novel. *It can be a work of science or engineering, too.*
Potential classics in science and engineering are being written today. Time alone can tell which of them will endure. Surely, they will be found among the books which are *today* accepted as leading authorities in their fields.
Bell Telephone Laboratories scientists and engineers have written many such authoritative books. They encompass the fields of information theory, semiconductor physics and chemistry, network theory, statistical quality control, sound and acoustics, traveling wave tubes and dislocations in crystals.
More than 40 of these technical works have been published since 1926. All have evolved from the Laboratories' continuing efforts to improve your Bell telephone service. They reflect the nature of the scientific thinking which helps keep this service the world's best.
BELL TELEPHONE LABORATORIES
WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

SARKES TARZIAN

NEW DIMENSIONS

in Silicon Power Rectifiers

Unique case styling of Tarzian silicon power rectifiers is the one visible difference that sets the Tarzian rectifier apart from the ordinary . . .

. . . BUT . . .

. . . this is the least important dimension of all. The other dimensions can't be seen, but when examined as to performance they present a perspective that clearly indicates why Tarzian rectifiers have been established as *the* performance standard by design engineers.

MEASURE . . .

. . . these parameters against similar ratings on the market . . .

DC CURRENT AMP**	TARZIAN TYPE	JUNCTION SIZE: TARZIAN TYPE	JUNCTION SIZE: *OTHER	THERMAL GRADIENT: TARZIAN TYPE	THERMAL GRADIENT: *OTHER	JUNCTION TEMP. RISE: TARZIAN TYPE**	JUNCTION TEMP. RISE: *OTHER
20	R	.25	?	10°C	?	60°C MAX	?
35	S	.375	?	9°C	?	60°C MAX	?
50	T	.625	?	5°C	?	60°C MAX	?
100	V	.75	?	5°C	?	60°C MAX	?
150	W	.875	?	7°C	?	60°C MAX	?
200	X	1.0	?	9°C	?	60°C MAX	?
250	Y	1.125	?	11°C	?	60°C MAX	?

*Check with other suppliers.
**with adequate cooling fin.

All types are available in positive and negative base polarity.
Where other rectifiers fail, Tarzian's perform!
Join the leading engineers who are specifying and using Tarzian rectifiers!
Engineering assistance and samples are available—write or phone.

SARKES TARZIAN INC. • RECTIFIER DIVISION

415 north college • bloomington, indiana • edison 2-1435

In Canada: 700 Weston Rd., Toronto 9, Tel. Roger 2-7535 • Export: Ad Auriema, Inc., New York City

Circle 14 on Inquiry Card

RAYTHEON coins* an important
RELIABLE
RAYTHEON
CIRCUIT-PAKS
* E PLURIBUS UNUM (one unit composed of many parts) aptly describes Raytheon Circuit-Pak.
Circle 15 on Inquiry Card

new word for designers and producers . . .

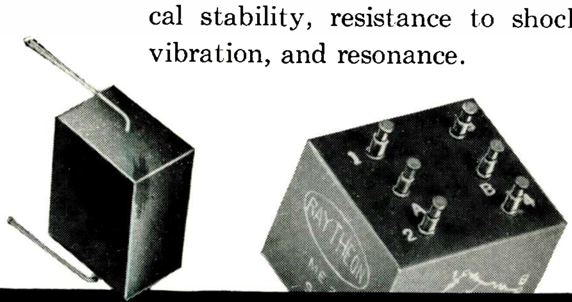
CIRCUIT-PAK

for the designer

1. **Space** — compact, encapsulated subassemblies assure maximum space utilization.
2. **Insulation** — better *internal* electrical insulation between circuit elements; better *external* insulation. Corona is minimized.
3. **Matching** — components may be electrically matched, then assembled or replaced as a single unit.
4. **Stability** — temperature stability in critical circuits is improved.
5. **Environment** — greater mechanical stability, resistance to shock, vibration, and resonance.

for the producer

1. **Maintenance** — input and output are quickly checked; circuits may be readily replaced.
2. **Inventory** — one item to buy and stock instead of multiple items.
3. **Assembly** — just plug it in and put it to work; many Circuit-Paks are available from stock.
4. **Design** — save time with Circuit-Paks that meet your specifications; they are ideal for applications such as comparators, bridges, choppers, flip-flops.
5. **Testing** — Raytheon Circuit-Paks are factory pre-tested — your test requirements minimized.



RAYTHEON

SEMICONDUCTOR DIVISION

RAYTHEON COMPANY

SILICON AND GERMANIUM DIODES AND TRANSISTORS • SILICON RECTIFIERS • CIRCUIT-PAKS

New York, PLaza 9-3900 • **Boston,** HIllcrest 4-6700 • **Chicago,** NAtional 5-4000 • **Los Angeles,** NOrmandy 5-4221 • **Orlando,** GArden 3-1553 **Syracuse,** HOward 3-9141 • **Baltimore,** SOuthfield 1-0450 • **Cleveland,** WInton 1-7716 • **Kansas City,** PLaza 3-5330 • **San Francisco,** FIreside 1-7711 **Canada:** Waterloo, Ont., SHerwood 5-6831 • **Government Relations:** Washington, D. C., MEtropolitan 8-5205

International News

(Continued from Page 25)

SOUTH AMERICA

Extend Bid Deadline on Communications System

The Republic of Panama has extended to December 14 the deadline for bids on the supply and installation of a modern telecommunications system.

The project includes furnishing and installing all equipment, instruments, and materials required to establish and operate the proposed system as well as the purchase of sites and construction of necessary buildings for housing the equipment and offices.

Copies of the invitation, Resolution No. 176, are available from the Trade Development Div., Bureau of Foreign Commerce, U. S. Dept. of Commerce, Washington 25, D. C.

New Computer Center

The largest electronic data processing center in Latin America is now in operation in San Juan, Puerto Rico. The center is processing paychecks of government personnel, planning road building programs, and standardizing forms and records.

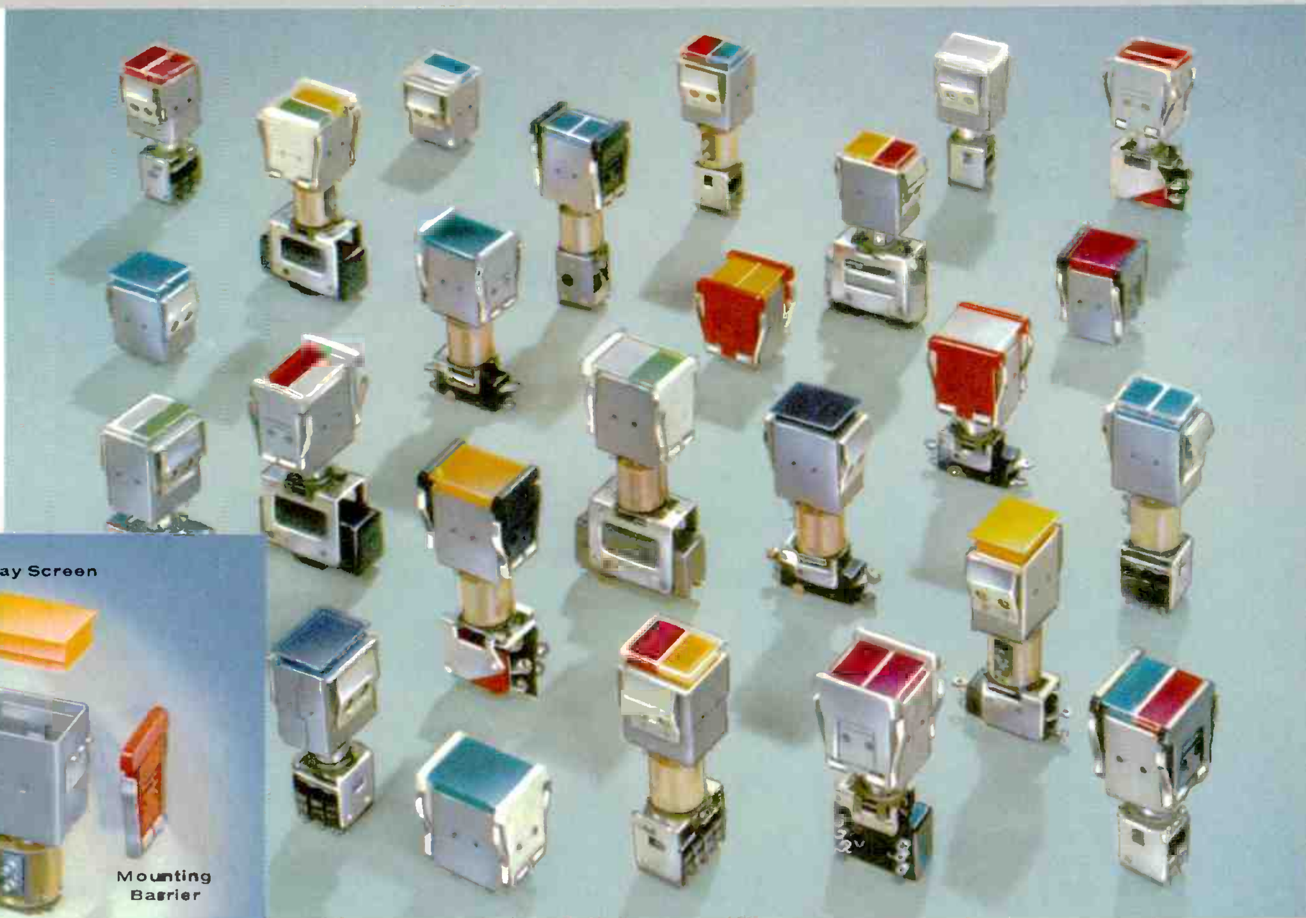
Heart of the center is an IBM 705 data processor which can read a reel of magnetic tape containing 5,000,000 characters in 6½ min., make 240,000 "decisions" a minute, and do more than 400 multiplications a second.

NATO COMMUNICATIONS NET

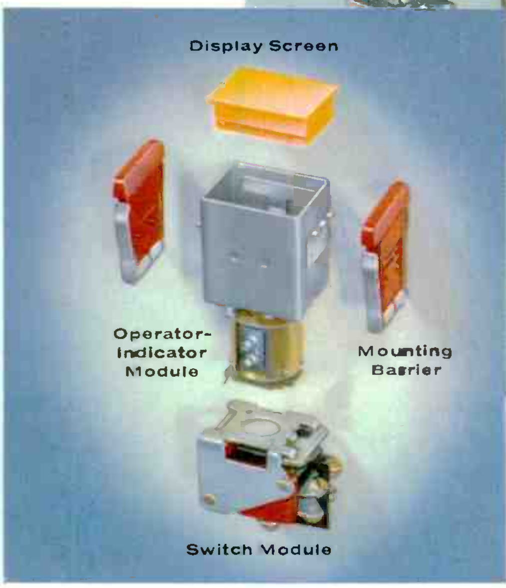
First units of NATO'S 6,500-mile "Ace High" communications network are inspected by Raymond F. Kelly (left), President of Dynamics Corp. of America and Major General Harold W. Grant, USAF. Unit is a quadruple diversity receiver for simultaneous receiving telephone, telegraph, and telemeter messages.

Circle 17 on Inquiry Card →

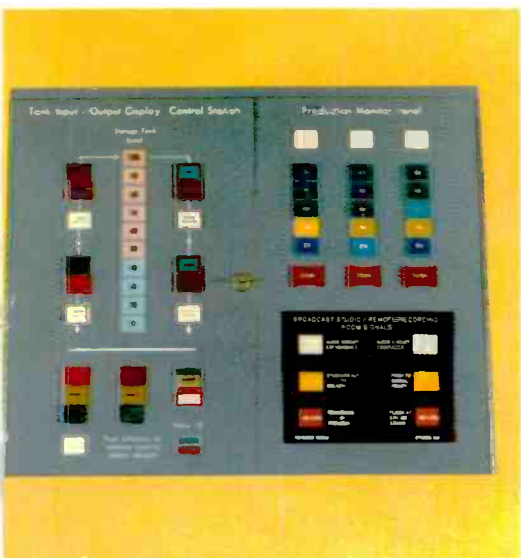
MICRO SWITCH Precision Switches



Just 25 of the hundreds of switch and indicator combinations



Modular concept allows wide choice of combinations. Parts snap together and into panels without tools.



Four Series 2 mounting types permit mounting singly or in columns or rows, provide panel design freedom.

Build your own lighted pushbutton switches and indicators with Series 2 modules

No tools are needed to put together Series 2 modular assemblies that provide a choice of hundreds of different control and display functions.

From our Catalog 67, you select modules from 48 different operator-indicator units, 12 indicators, 18 switch units, 16 mounting barriers differing in size and color, 40 color display screens, and 4 filters.

Up to 4 lamps in each Series 2 indicator module provide improved signal reliability, and choice of transmitted or projected signal color.

Catalog 67 describes Series 2 devices and switching units in detail . . . contains helpful information and application data for human factors engineers and for electrical engineers. Catalog 67 and application assistance are available on request from the MICRO SWITCH branch office near you. Or write for your copy.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls Limited, Toronto 17, Ontario

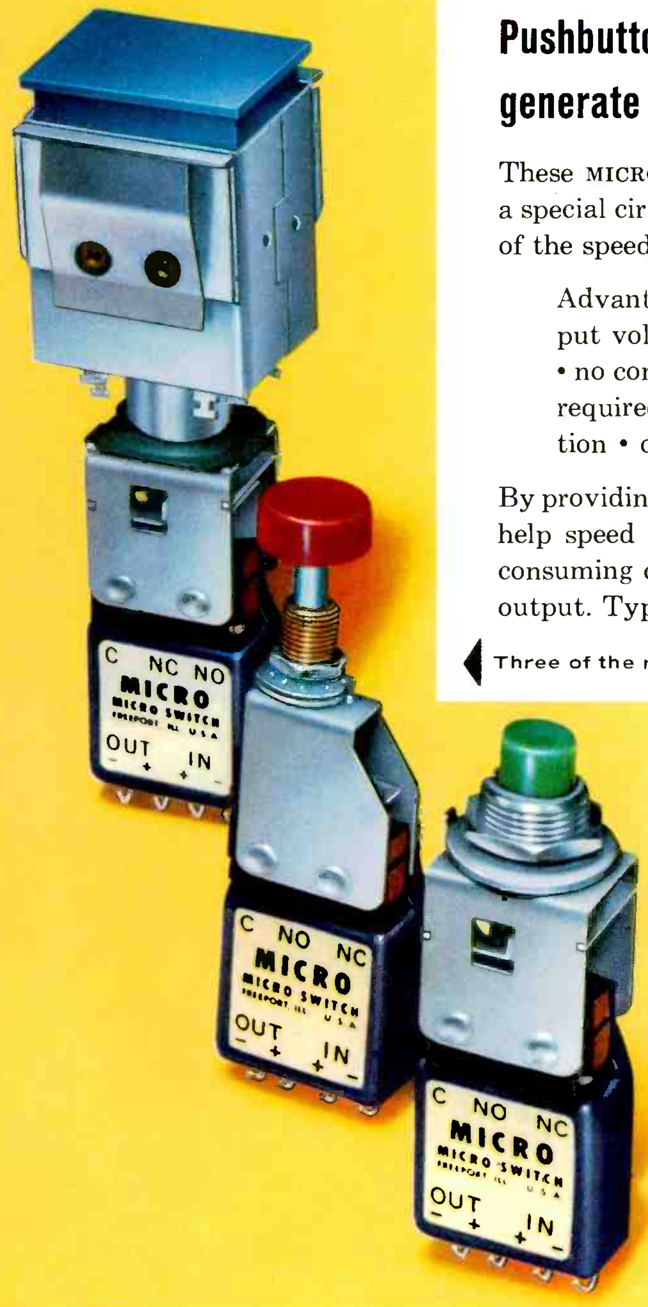
Honeywell
MICRO SWITCH Precision Switches

Pushbutton switches with built-in "One-Shot" circuit generate one square pulse per operation

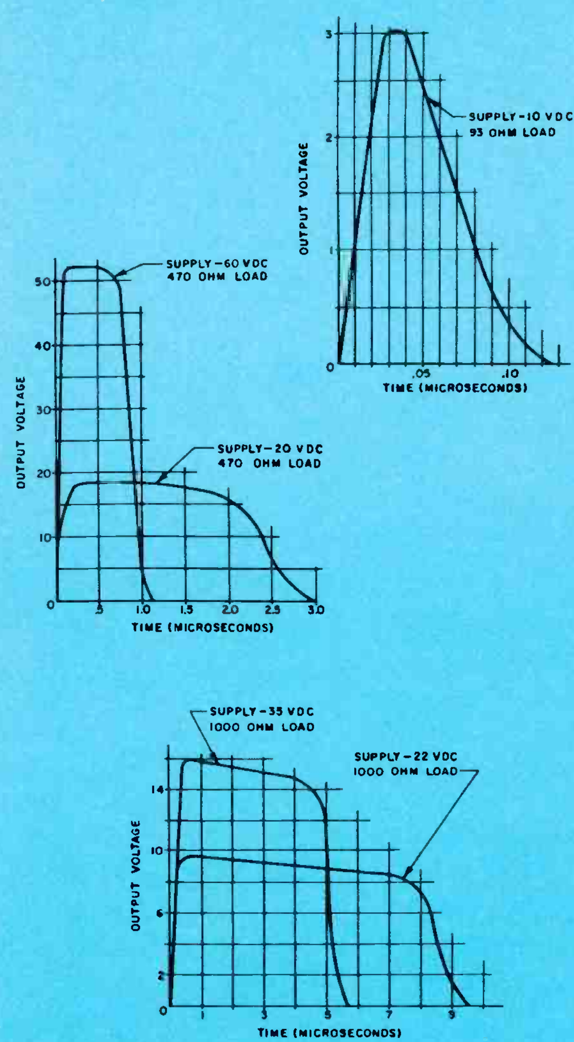
These MICRO SWITCH snap-action pushbutton assemblies incorporate a special circuit which produces a single square wave pulse, regardless of the speed of operation.

Advantages are: pulse widths from 0.1 to 10.0 microseconds • output voltages up to 180 volts • can drive loads as low as 5 ohms • no constant power drain • produce positive or negative pulse, as required • potted circuit for physical and environmental protection • operate at temperatures from —65° to +185° F.

By providing a pre-engineered, compact package, "One-Shot" switches help speed up equipment design by eliminating the need for time-consuming custom circuit development to accomplish a shaped wave output. Typical output curves are illustrated below:



Three of the many available "One-Shot" switch assemblies



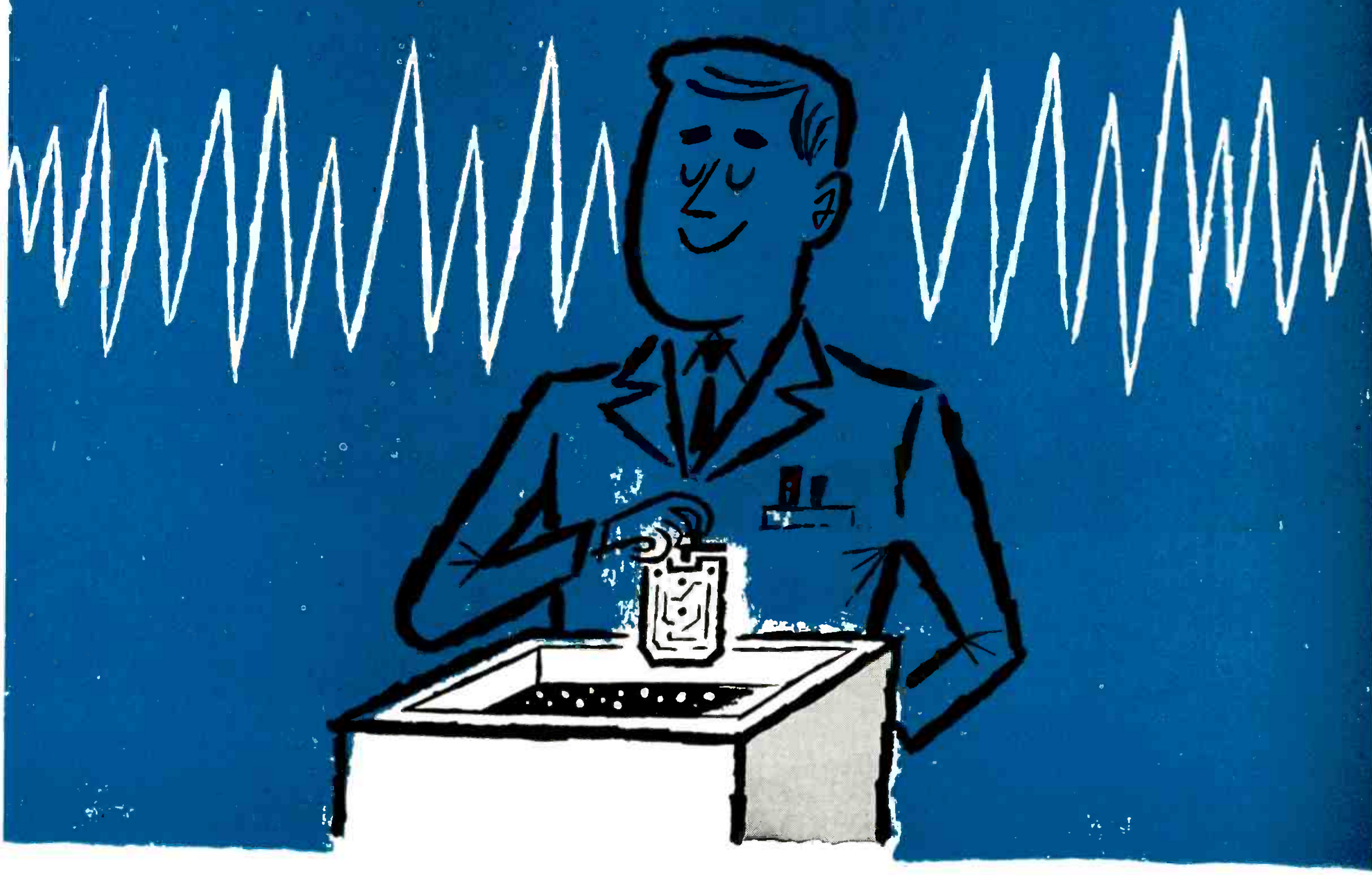
The "One-Shot" switch can be supplied as an integral unit with any MICRO SWITCH pushbutton device. Applications include computer and radar consoles, keyboards, electronic test equipment, checking ring counters, setting and resetting flip-flops, and reflected pulse systems. Ask for data sheet 150.

Engineering assistance on switch application is available from the MICRO SWITCH branch office near you. Consult the Yellow Pages.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls Limited, Toronto 17, Ontario

Honeywell
MICRO SWITCH Precision Switches

CLEAN ELECTRONIC PARTS CLEANER ULTRASONICALLY!



Save labor, save time—*blast* away dirt and dust by the remarkable ultrasonic method that Acoustica has developed to a fine point of efficiency. The hard-to-get-at parts in the most intricate electronic instruments are cleaned as easily as the most exposed parts. The powerful "cavitational" action of an Acoustica ultrasonic tank radiates to the innermost places, removes the most stubborn dirt or dust. Transistors, potentiometers, vacuum tubes, and scores of other products are thoroughly cleaned and decontaminated this modern, efficient way. Many leaders in the electronic industry have changed to Acoustica ultrasonic cleaning!

Acoustica is the recognized leader in quality ultrasonic cleaning equipment, the sole producer of the *Multipower* transducer. An Acoustica *certified* ultrasonic application is your assurance of maximum cleaning efficiency!

Acoustica Associates, Inc., Fairchild Court, Plainview, N. Y., 10402 Aviation Blvd., Los Angeles, Calif.

← Circle 18 on Inquiry Card

acoustica

THE GREATEST NAME IN ULTRASONICS

Circle 19 on Inquiry Card

Tele-Tips

HELICAL ANTENNAS—Why is the corkscrew configuration best suited for tracking space vehicles? We've wondered about this from time to time, promising that some day soon we would dig into the books and find out. On a junket to Technical Appliance Corp. (TACO) last month we got the answer—and it's almost ridiculously simple. Shortly after launching the missile is set spinning—like a rifle bullet—to provide spin-stabilization. Antennas mounted on the surface of the missile then follow a corkscrew pattern, radiating a pattern that is neither horizontally polarized nor vertically polarized. The helical antenna matches this pattern.

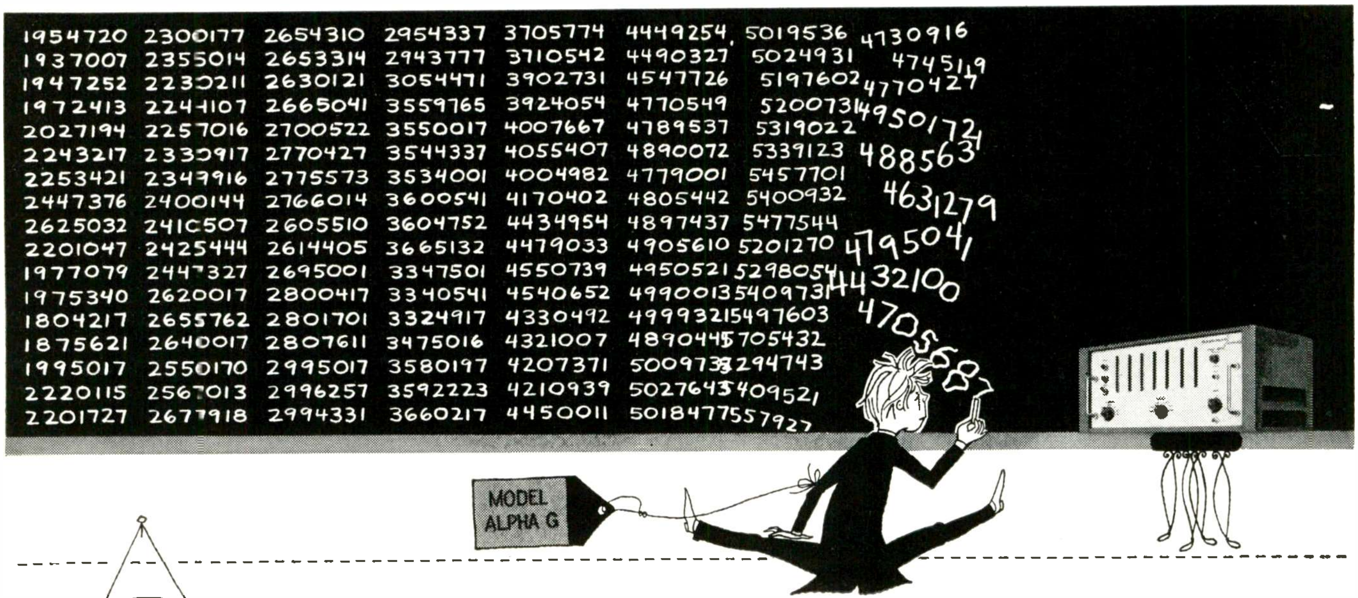
COMMUNIST RADIO is using quiz contests as propaganda media in satellite areas. Big prizes are trips behind the Iron Curtain.

"YOUNGEST HAMS." The FCC fished through the files of the 200,000 amateur radio license holders to find their youngest and oldest "hams." Search turned up one youngster, blind from birth, who qualified for a general class license when only seven years old. On the other end, qualifying for a novice license, was an 86-year-old doctor.

PROJECT to determine the qualities of the ideal communications officer has turned into a machine called EVATA — Electronic Visual-Auditory Training Aid—that promises to ease the job of teachers all over the country. The device has a 35-mm. projector, a tape recorder, and an instrument panel which enables the student to answer questions based on material presented by the machine. The finished tape shows the student's answer, the right answer, and the length of time the student took to arrive at his answer.

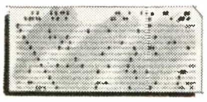
(*Continued on page* 46)

This data converter is no longer available

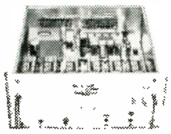


Alfonso Gotlentz, winner of the 1958 Data Conversion Competition, chalked up 16,792 Beckman counter readings in a record time of 7 hrs. 23 min. Unfortunately, Alfonso developed digitized eyeballs, a common occupational disability of mammalian data converters. Undismayed by the untimely end of his conversion career, he speedily procured electroluminescent contact lenses; now performs as a two-digit in-line display.

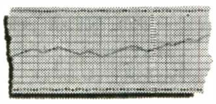
replacing Alfonso, these more clever converters . . .



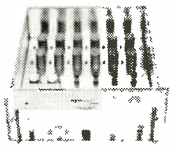
To put Beckman counter readings on punched IBM cards, you can get



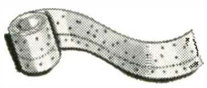
Model 3110 (for serial punch) or Model 3100 (for parallel punch)



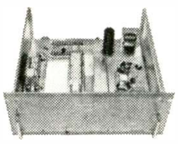
To make a strip chart record of changing counter readings, you may procure



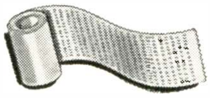
Model 3120, a digital-to-analog converter with resistance ratio output



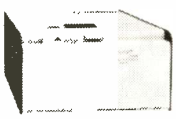
To make a punched paper tape of counter readings, ask for



Model 3101 (drives a tape punch)



To print counter readings much faster than Alfonso, try



Model 1452, a digital recorder that prints 7, 8 or 10 digits

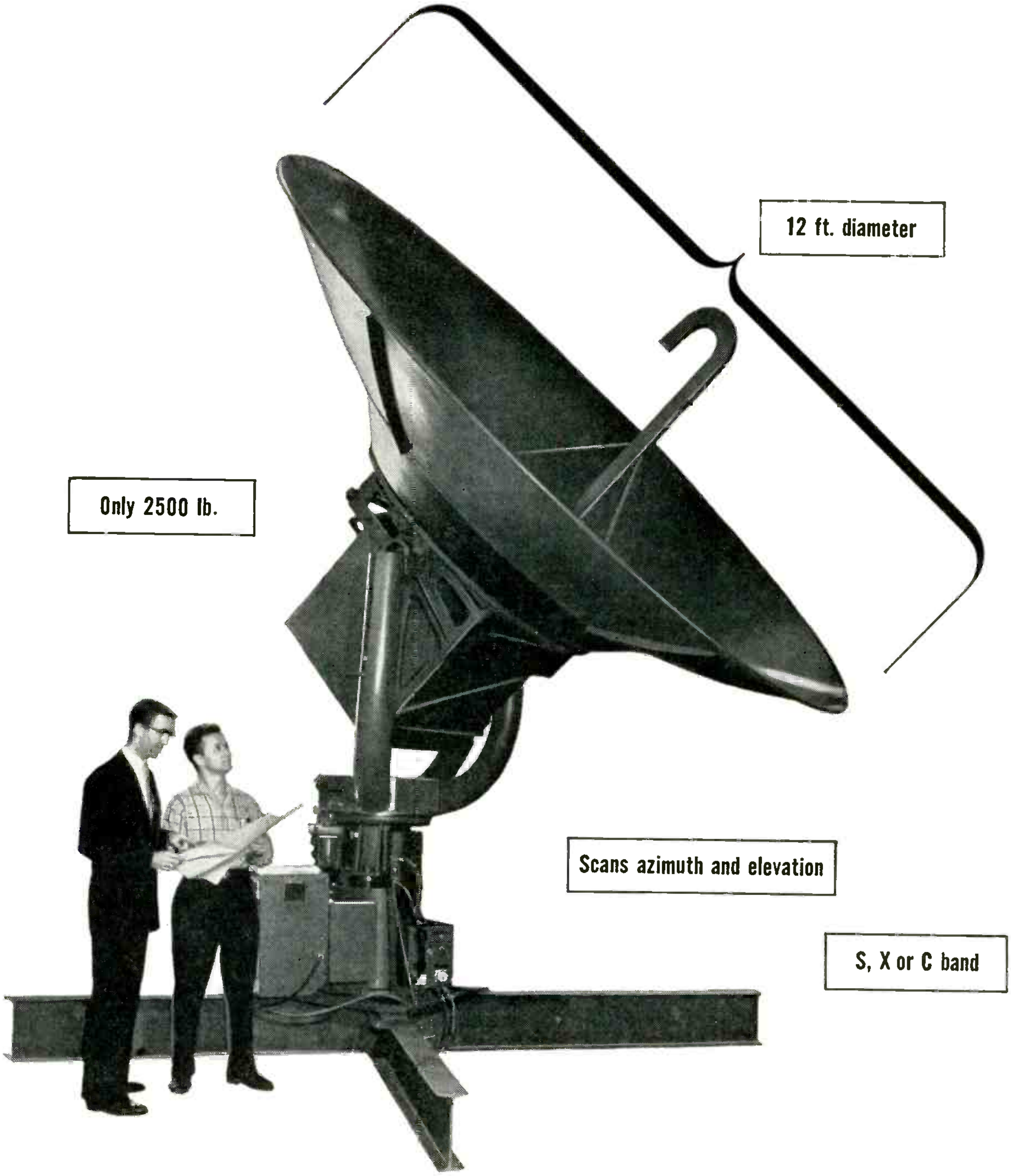
Beckman® | *Berkeley Division*

2200 Wright Avenue, Richmond 3, California

a division of Beckman Instruments, Inc.

T23

Write for detailed technical bulletins



TO FIND STORMS 250 MILES OUT

At Miami, Fla., this new I-T-E antenna hunts for hurricanes long before they get close enough to do damage. It's the first of 39 such antennas in the U.S. Weather Bureau's new "Storm Finder" long range radar network.

I-T-E designed and built the complete antenna, including pedestal, and designed the servo system. The reflector, made big for long range, is of spun aluminum for light weight. Hence it can be rotated and tilted for fast scanning with minimum power.

When you select I-T-E to design and build radar or scatter communication antennas, you benefit from experience on an impressive list of the major systems installed to date. In addition, I-T-E's specialized plant facilities insure you of close tolerance fabrication for smooth, low-upkeep performance. Assignments are invited from prime contractors and Government agencies. Write in confidence. And ask for a copy of I-T-E's recently revised Antenna Handbook. I-T-E Circuit Breaker Company.

I-T-E CIRCUIT BREAKER COMPANY
Special Products Division • 601 E. Erie Avenue • Philadelphia 34, Pa.

Constant reliability . . . duplicated in volume

CLEVITE

DIODES

Clevite diodes feature high forward conductance, fast pulse recovery, fast forward switching and extreme ruggedness to resist vibration and shock and to provide exceptional reliability

GOLD BONDED GERMANIUM GLASS DIODES
SILICON GLASS DIODES

- *Fast Switching Types*
- *General Purpose Types*
- *Military Approved Types*

TRANSISTORS

Low thermal resistance, low saturation resistance plus superior current gain and high reliability construction make Clevite transistors your first choice for such applications as power converters, audio amplifiers, power supplies and high current switching circuits.

GERMANIUM POWER TRANSISTORS

- *2 & 4 Watt Audio Types*
- *5 Ampere Switching Types*
- *High Power 65 Watt & 15 Amp Types*

Available at leading electronic distributors in principal cities.

SEND FOR
Short Form Catalog 59

CLEVITE TRANSISTOR
254 CRESCENT STREET • WALTHAM 54, MASS.

JERROLD WIDE BAND PORTABLE SWEEP GENERATOR

NEVER BEFORE SO VERSATILE AN INSTRUMENT AT SO LOW A PRICE!

$295.00

Jerrold's Model 601 and 602 are unexcelled for laboratory and production field use—combining portability and ruggedness with precision performance and versatility usually associated with only the costliest laboratory equipment. NOW . . . FULL PRODUCTION ASSURES FAST DELIVERY!

ONE INSTRUMENT COVERS MOST COMMONLY USED I. F. FREQUENCIES

For frequency ranges 12 to 225 mcs . . . specify Model 601
For frequency ranges 4 to 112 mcs . . . specify Model 602

- All electronic . . . saturable reactor sweep circuit
- Fundamental frequency output on all ranges
- Output VSWR less than 1.1
- High output level adjustable by switch attenuators

For full details write:

JERROLD ELECTRONICS CORPORATION, Industrial Products Division
Dept. TED 55 Jerrold Building, Philadelphia 32, Pa.
Jerrold Electronics (Canada) Limited, Toronto
Export Representative: Rocke International, New York 16, N. Y.

HIGH

OUTPUT!

601 - 1.0 Volt RMS into 50Ω Load
602 - 2.5 Volt RMS into 50Ω Load

WIDE

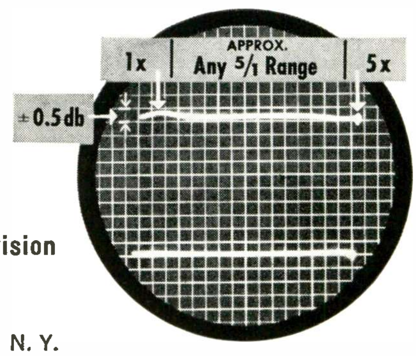
SWEEP WIDTHS!

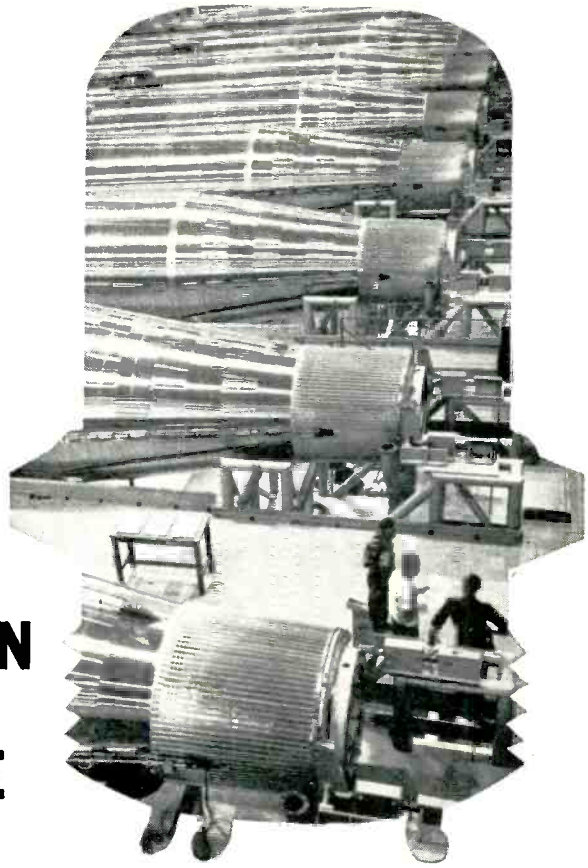
As wide as 5 to 1
As narrow as 1% of C.F.

FLAT

OUTPUT!

RF flat within ±0.5 db





THIS VOLTAGE REGULATION PROBLEM HAD TO BE SOLVED FOR AUTOMATIC INSPECTION MACHINES

Hoffman Silicon ZENER Devices were the solution

Design engineers of American Bosch Arma*, in order to develop a completely automatic VOLTAGE REGULATOR TEST SET, required extremely stable and close tolerance circuit components. Hoffman Zener Devices were chosen to solve three major circuitry problems: (1) as shunt voltage regulation in a rectifier circuit, (2) as a reference element in a regulated power supply, and (3) as current limiters to prevent saturation in a transistor circuit.

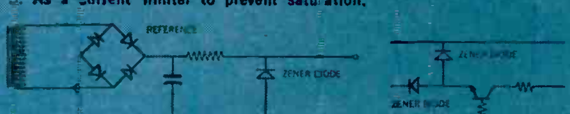
ABAMCO engineers, using Zener circuitry, were able to create a production test instrument which eliminates operator judgment error and decreases labor to 25% of previous requirements.

Hoffman Semiconductor, who pioneered the development of Silicon Zener Devices, offers you the widest selection of voltage types and power dissipation ratings in the field.

Consult our Semiconductor Application Specialists in your immediate area or write to Department ZD.

Circuit applications of zener devices in Voltage Regulator Test Set:

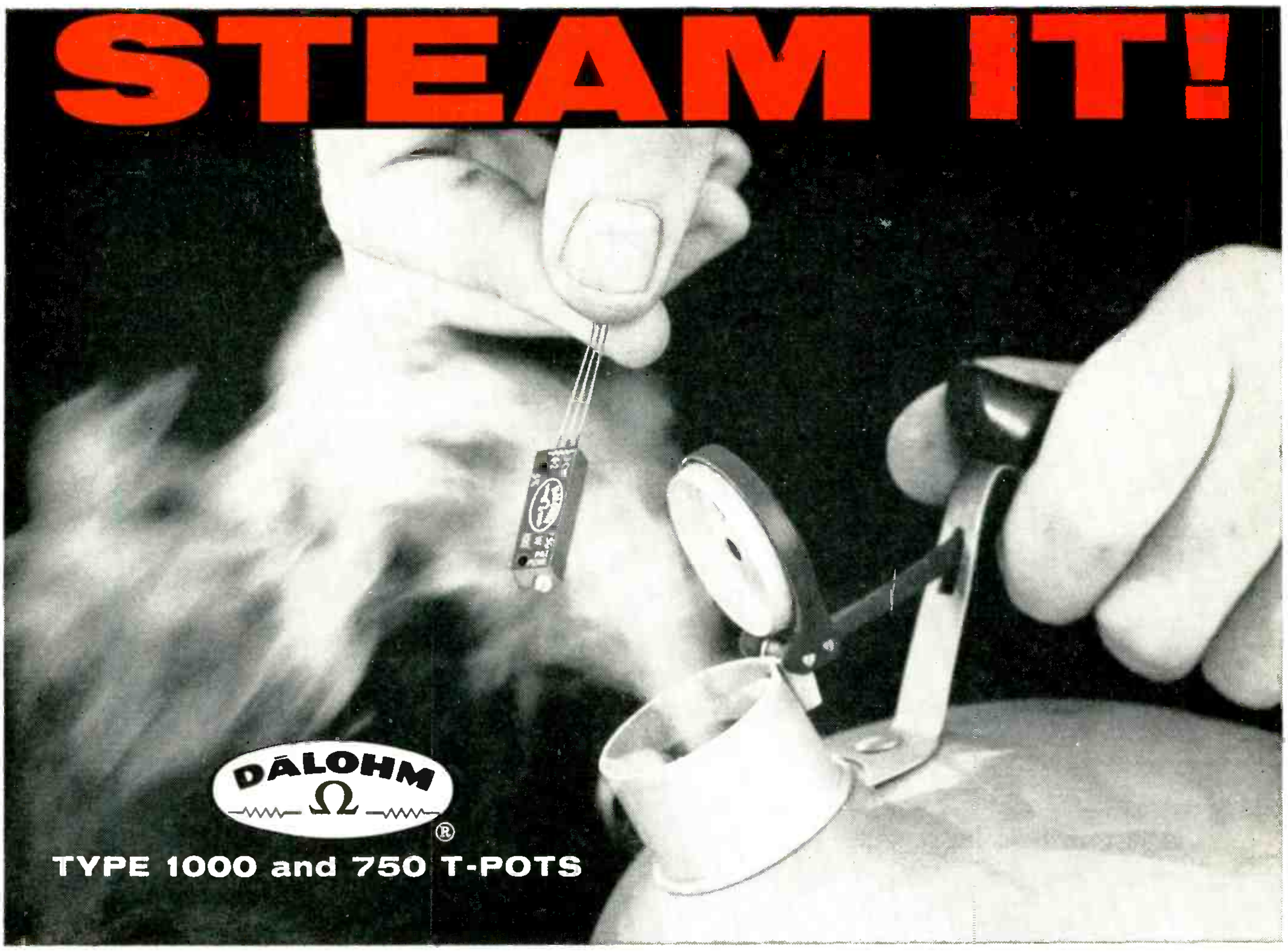
1. As shunt voltage regulator
2. As a reference element, regulated power supply.
3. As a current limiter to prevent saturation.



*ABAMCO.

If you need a job in electronics done quicker and better, contact

Hoffman Electronics
CORPORATION
SEMICONDUCTOR DIVISION
930 PITNER AVENUE EVANSTON, ILLINOIS



INHERENT STABILITY

Assured in a DALOHM 750 or 1000 Trimmer Potentiometer

The ability to perform reliably under extreme conditions of heat and humidity is only one mark of the inherent stability that is standard in Dalohm trimmer potentiometers.

Stored on the shelf for months . . . or placed under continuous load . . . operating in severe environmental, shock, vibration and humidity conditions . . . Dalohm precision trimmer potentiometers retain their stability because it has been "firmly infixed" by Dalohm design and methods of manufacture.

For all applications demanding trimmer potentiometers that meet or surpass MIL specifications, you can depend on Dalohm.

WIRE WOUND • SEALED • HIGH POWER • DALOHM TYPE 750 and 1000 TRIMMER POTENTIOMETERS

Miniature and standard sizes with completely sealed cases. Three terminal configurations provide the solutions for demanding design problems.

	750	1000
Rated at	2 watts	2.5 watts
Resistance range	10 ohms to 30K ohms	10 ohms to 50K ohms
Standard tolerance	± 5%	± 5%
Size	.180" x .300" x 1.000"	.180" x .300" x 1.25"
Screw adjustment	17 ± 2 revolutions	25 ± 2 revolutions
Weight	2 grams	2.5 grams

- Completely sealed
- Meets humidity requirements of MIL-STD-202A, Method 106A or MIL-E-5272A, Procedure 1
- End resistance is 3%, maximum
- Nominal resolution is from 0.1% to 1.2%
- Temperature coefficient is 50 PPM/° C.
- Meets load life requirements of MIL-R-19A
- Surpasses applicable paragraphs of MIL-R-12934A

Write for Bulletins R-41A and R-44, with handy cross-reference file cards.

SPECIAL PROBLEMS?

You can depend on DALOHM, too, for help in solving any special problem in the realm of development, engineering, design and production. Chances are you can find the answer in our standard line of precision resistors (wire wound, metal film and deposited carbon); trimmer potentiometers; resistor networks; collet-fitting knobs; and hysteresis motors. If not, just outline your specific situation.

from **DALOHM**
Better things in smaller packages
DALE PRODUCTS, INC.
1304 28th Ave., Columbus, Nebr.

Tele-Tips

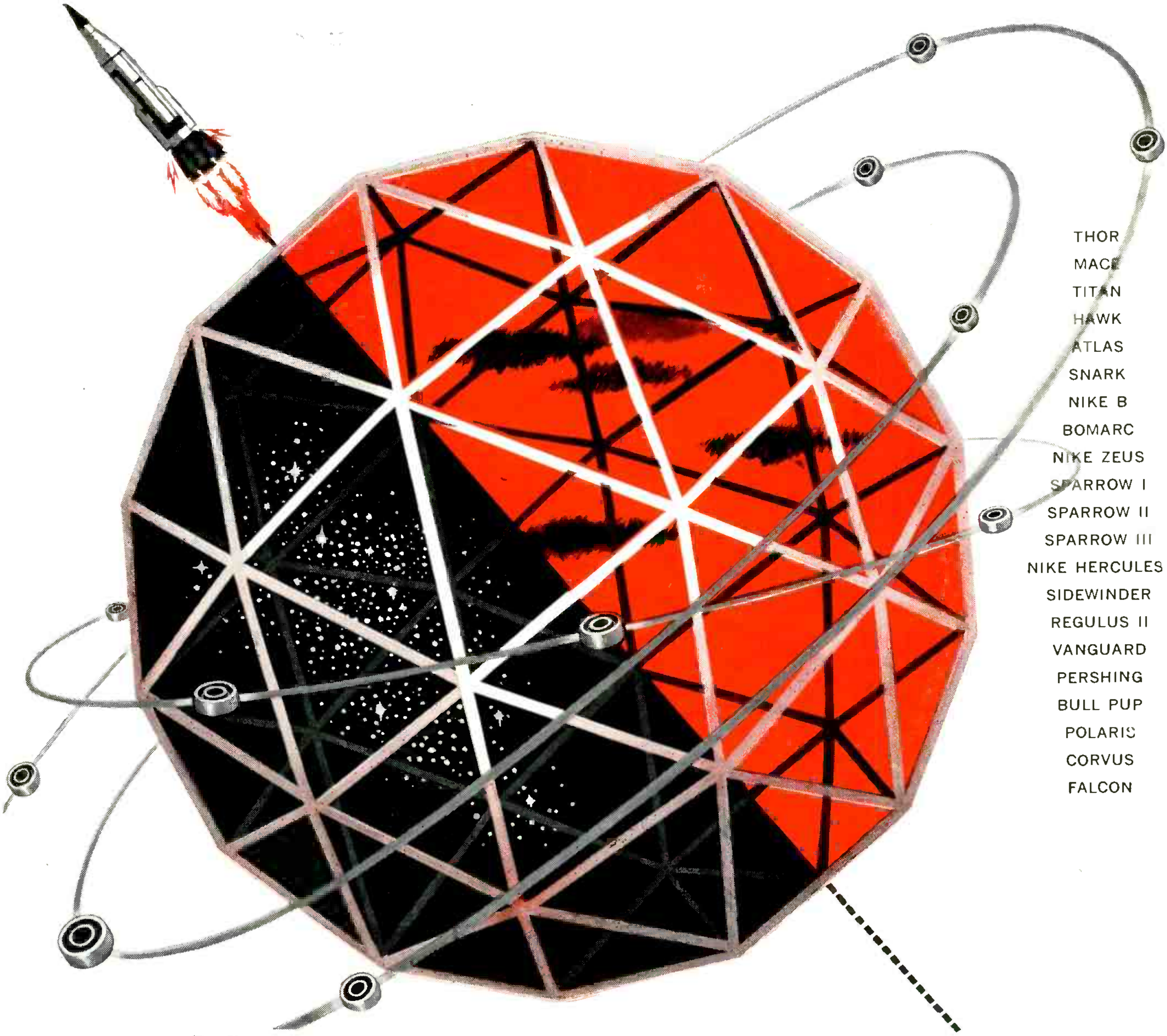
(*Continued from page* 36)

CHRISTMAS GIFT subject got a few words from The Business Goodwill Advisory Council. They advise firms: 1, Keep gifts of modest value; 2, choose gifts individually, referring to recipients' tastes; 3, personalize each gift, if possible; 4, accompany each gift with a personal note or card: 5, deliver each gift with a flair, if possible—personally or by messenger—and preferably to the recipient's home rather than to his office.

TV CAMERA attached to the eyepiece of the 36-in. Warner and Swasey Observatory (Cleveland) telescope provides detail even superior to direct viewing. The televised pictures are being flashed on the screen of the observatory's auditorium so that hundreds of visitors can watch simultaneously. Earlier, viewers had to take brief turns at the telescope's eyepiece.

COMPUTERS may eliminate business transactions by cash or check, if the public can be educated to the change. Computer technology is already capable of handling automatically transactions at shopping centers, utilities, hotels, and public transportation offices, merely by the customer's insertion of a universal credit card.

GIFTED YOUNGSTERS, with a particular talent for sciences, are getting special attention from the California State Polytechnic College, with assistance from the Leach Corp. Plan centers around a home laboratory program coordinated by the College, with equipment supplied by Leach. Talented youngsters in the grammar school grades are referred to the College by their local teachers, and if the boy or girl shows sufficiently outstanding abilities an advanced laboratory program is set up for him in his school. This will also encourage the interest of other local students in the science studies.



New ND Processes Improve Instrument Sensitivity!

In delicately-precise instrumentation, parts must react to relatively small rotive forces. Here . . . bearing torque is the highly critical factor. Separator selection, bearing finish and clinically clean assembly areas are extremely important.

It's here that New Departure is setting new industry standards! Special dies and in-process gauging of separators assure ball retention with improved torque and vibration characteristics. In addition, new N.D. honing processes and Talyrond gauging deliver uniform accuracy to millionths of an inch. Moreover, having originated the first bearing industry "white room", followed by continuous experience, New Departure's present day, modern assembly areas approach fantastic levels of cleanliness.

An everyday example of N.D.'s contribution to improved instrument sensitivity can be found in the Smithsonian Institution-selected Micro Clocks. These vitally important instruments are accurately tracking both U.S. and foreign satellite movements in time determinations of 1 milli-second . . . and better!

For new *performance* and *reliability* in your precision instruments, ask your N.D. Miniature/Instrument Bearing *Specialist* to sit in on early design level discussions. For further information call or write Department L.S., New Departure Division, General Motors Corp., Bristol, Conn.

ND

NEW DEPARTURE

MINIATURE & INSTRUMENT BALL BEARINGS

proved reliability you can build around

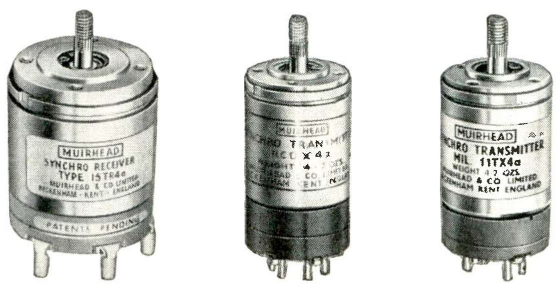
Circle 31 on Inquiry Card

Install

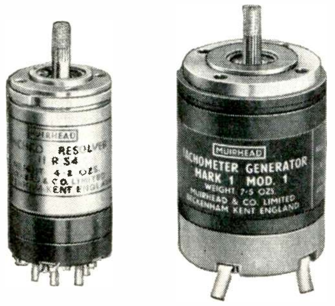
MUIRHEAD

Servo Components

Types include Control Transmitters, Control Differential Transmitters, Control Transformers, Torque Transmitters and Receivers, Torque Differential Transmitters, Resolvers, Linvars, Servomotors, Motor Tachometers and Tachometer Generators. Where military specifications exist, Muirhead Servo components can be supplied satisfying Ministry of Supply, Bureau of Ordnance and N.A.T.O. requirements.



And obtain the Ultimate in Performance from your Electromechanical Design



A concise index to all the types manufactured is available in the Muirhead Synchro Broad Sheet, which will be forwarded on request. Detailed information on individual types is also available in handy data sheet form.

425

MUIRHEAD INSTRUMENTS INC · 441 LEXINGTON AVE · N.Y.17 · U.S.A.
'Phone Murray Hill 2-8131

MUIRHEAD INSTRUMENTS LTD · STRATFORD · ONTARIO · CANADA
'Phone 3717-8

MUIRHEAD & CO. LIMITED · BECKENHAM · KENT · ENGLAND
'Phone BEC 4888

on request

MUIRHEAD

TECHNIQUE

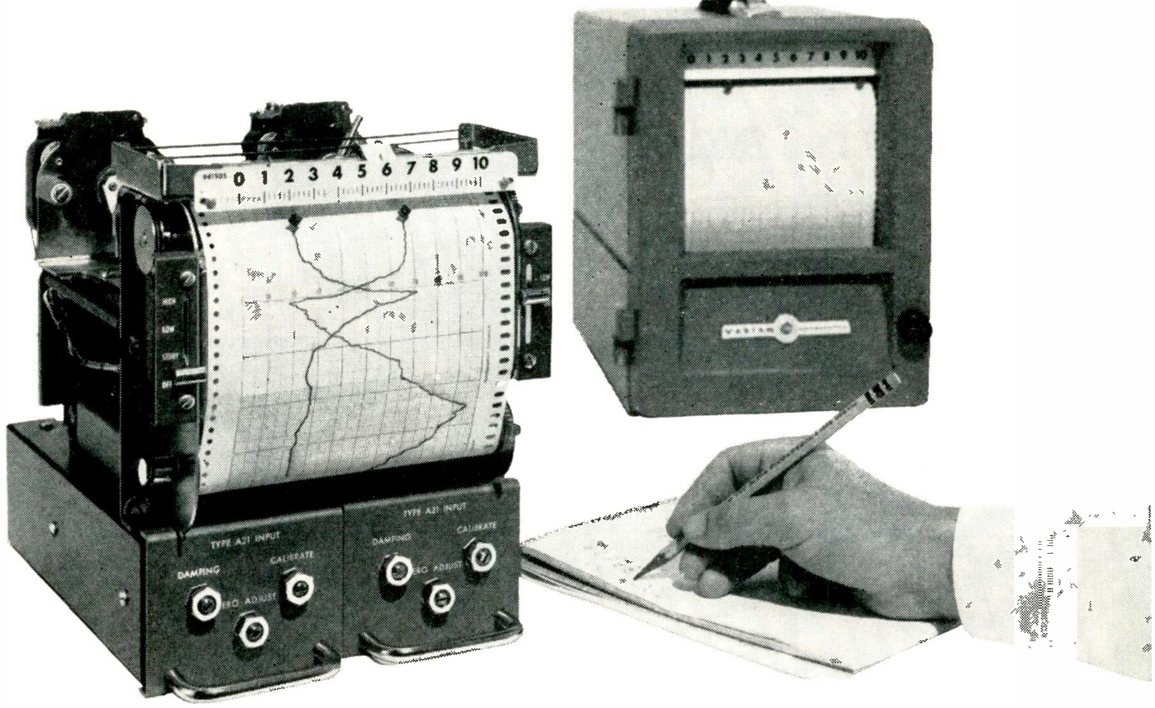
A Journal of Instrument Engineering
for
Scientists, Engineers, Technicians,
Research Workers

MUIRHEAD & CO. LIMITED
BECKENHAM · KENT
ENGLAND

Announcing the newest

VARIAN Potentiometer RECORDER

the Dual Channel G-22



MOST COMPACT AND PORTABLE

TWO-CHANNEL RECORDER

Size and price need no longer limit the use of two-channel recorders. The Varian G-22 is the least expensive servo-operated two channel available —and also the most compact. It puts two time-correlated variables onto one chart of 5-inch calibrated width.

The Varian G-22 is of completely modular design—and a truly versatile instrument. Plug-in input chassis are interchangeable to provide various recording characteristics. Chart motors are easily changed for additional speeds. Range is adjustable from 0-9 mv to 0-100 mv on the basic input chassis. Zero can be set anywhere across the chart. And being a potentiometer recorder, the G-22 has the necessary sensitivity to serve a wide variety of recording needs.

FEATURES

- Potentiometer measuring circuit thousands of times more sensitive than a galvanometer.
- Quickly interchangeable plug-in input chassis provide various recording characteristics.
- Two-speed gear shifter standard; four chart speeds available by dual motor option. Choice of speeds from ⅛ in/hr to 8 in/min.
- Modular construction throughout; permits rapid removal of subunits with a screwdriver.
- Panel mount or portable versions available. Total weight is 35 pounds.
- 1% limit of error and one second full-scale balancing time.
- Cast aluminum case and box frame structure provide ruggedness.
- Direct shaft connection between servo motor and potentiometer provides positive drive and allows space for optional accessories.
- Accessories include retransmitting slidewires, event markers, and alarm contacts.
- Capillary pens and large reservoirs provide reliable inking.
- Only $975 complete

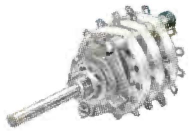
For full information, write the Instrument Division

VARIAN associates
PALO ALTO 19, CALIFORNIA

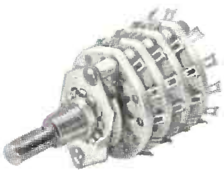
Circle 33 on Inquiry Card

Solving switch problems fast...

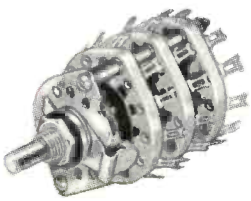
your job...and Centralab's



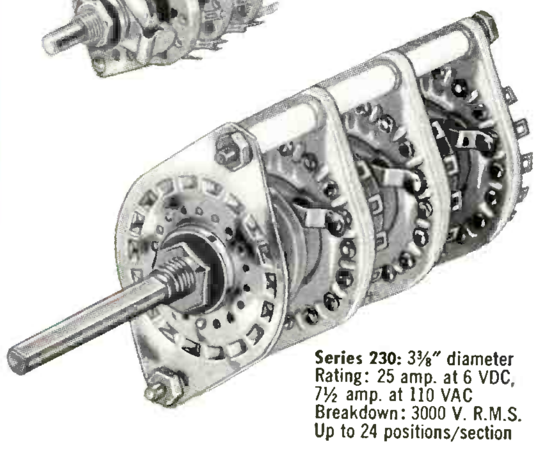
Series 100: 15/16" diameter
Rating: 0.5 amp. at 6 VDC,
100 ma at 110 VAC
Breakdown: 750 V. R.M.S.
Up to 12 positions/section



Series 20: 1 5/16" diameter
Rating: 2 amp. at 15 VDC,
150 ma at 110 VAC
Breakdown: 1500 V. R.M.S.
Up to 12 positions/section



Series 275: 1 7/8" diameter
Rating: 2 amp. at 15 VDC,
150 ma at 110 VAC
Breakdown: 1500 V. R.M.S.
Up to 23 positions/section



Series 230: 3 3/8" diameter
Rating: 25 amp. at 6 VDC,
7½ amp. at 110 VAC
Breakdown: 3000 V. R.M.S.
Up to 24 positions/section

Your switch problems can be solved quickly and efficiently at CENTRALAB. No matter how unusual or difficult the switch, you can get samples fast, quotations fast, and production fast! This is a result of years of specialized experience and superior facilities for designing and manufacturing a wide variety of switch types.

Typical of the extensive range of units available to you are the four CENTRALAB ceramic section switches shown here. These switches, and many others, are also available with phenolic sections, for economy applications, or where a larger number of positions is required.

DESIGN AIDS FOR ENGINEERS

CENTRALAB'S unique Switch Visualizer, which simulates actual switch operation, will help you simplify and speed up switch design. Used in conjunction with our detailed layout sheets (available for all CENTRALAB switch types), they greatly facilitate your job in switch design (and ours, too). Write for them today—along with a copy of CENTRALAB Switch Catalog 42-405.

Centralab CRL ®

P-5917

A Division of Globe-Union Inc.
938L E. KEEFE AVE. • MILWAUKEE 1, WIS.
In Canada: 669 Bayview Ave., Toronto 17, Ont.

VARIABLE RESISTORS • ELECTRONIC SWITCHES • PACKAGED ELECTRONIC CIRCUITS • CERAMIC CAPACITORS • ENGINEERED CERAMICS

AUTOMOBILES

RADIOS

TELEVISIONS

HERE

TAPE RECORDERS

COMPUTERS

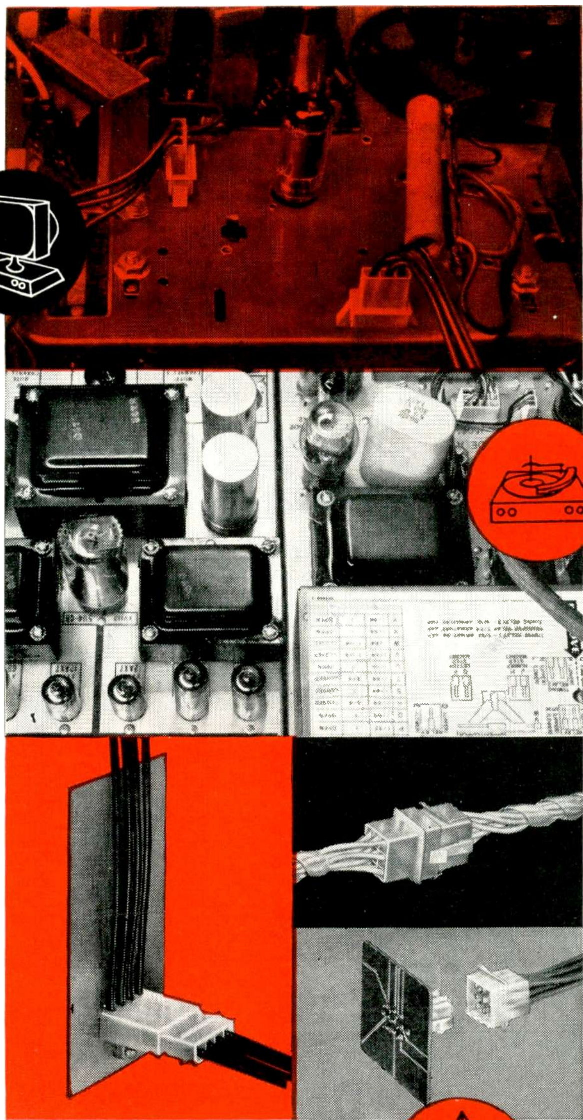
JUKE BOXES

VENDING MACHINES

X-RAY MACHINES

BUSINESS MACHINES

MOTORS



AIR CONDITIONERS

TRAFFIC APPLIANCES

ELECTRIC REFRIGERATORS

THERE

HI-FI EQUIPMENT

PHONOGRAPHS

ELECTRIC WASHERS

ELECTRIC RANGES

ELECTRIC DRYERS

EVERYWHERE

You won't have to look far to find an AMP-lok Multiple Circuit Connector. AMP-lok connectors have been used for the most diverse applications . . . for disconnecting multiple leads on—television deflection yokes, phonograph turn tables, electric ranges, washer and dryer control panels, and automotive instrument panels.

There are good reasons for the growing use of AMP-lok: It is available in 3, 4, 6, 9, or 12 circuit combinations. Attachment and assembly speeds run to thousands per hour. Uniform, reliable electrical characteristics are assured through AMP's compression crimp method. Automated techniques reduce total installed cost.

Versatility, reliability, economy and outstanding assembly speed—these factors explain why millions of AMP-lok connectors are being used everywhere. If you aren't using them for your circuit requirements, send today for more information

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

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

Circle 35 on Inquiry Card

LETTERS TO THE EDITOR

'Ideas—Insure The Future!'

Editor, ELECTRONIC INDUSTRIES:

I have read with interest your lead editorial on page 1 of the October, 1959, issue of ELECTRONICS INDUSTRIES, describing your plans to publicize "New and Unusual Electronic Devices for Consumer Use."

Our company possesses a wide range of electronic and mechanical skills, and enjoys rapid growth in the microwave electronics field. We are currently looking for an opportunity to diversify into commercial electro-mechanical product lines.

Thank you very much for your cooperation.

William A. Searle, Jr.
Asst. to the Vice-President

Microwave Development Laboratories
92 Broad St.
Babson Park 57,
Wellesley, Mass.

Editor, ELECTRONIC INDUSTRIES:

Your editorial, "Ideas—Insure the Future!" on Page 1 of the October issue attracted my attention. I'd like to publish something of this nature in the next issue of our bulletin.

Attached are copies of bulletins we have issued which are still in print.

Maybe you would consider favorably the idea of making mention of these bulletins in the next issue of ELECTRONIC INDUSTRIES because we would be happy to send them to anyone who would like to receive them.

R. George Roesch, President
and General Sales Manager

The Eraser Company, Inc.
1068 South Clinton Street
Syracuse 4, New York

Ed.: The bulletins described by Mr. Roesch are on the subject, "Reliable Electrical Connections," summarizing design hints from various electronic manufacturers. For copies, write to The Eraser Co.

"Microwave Issue"

Editor, ELECTRONIC INDUSTRIES:

I have just seen your November issue of ELECTRONIC INDUSTRIES and find much of the information contained therein of interest and importance to my work in the microwave electronics field. I should like to extend my compliments for your comprehensive microwave issue which will serve as a significant and worthwhile contribution to the industry.

I would like to request reprints of all your feature articles in both the November and December issues, but it would perhaps be simpler to request the complete issues. I am not presently on your mailing list, but would like to know if I might qualify for inclusion on your circulation list.

Thank you.

Dr. Richard C. Becker
Senior Staff Engineer

Amphenol-Borg Electronics Corporation
25th Avenue at Cermak, Broadview, Illinois (Chicago suburb)

Ed.: Dr. Becker certainly does qualify, and he will be added to our circulation just as soon as there is a vacancy.

Thanks!

". . . My thanks for this service and for your excellent magazine. I sincerely appreciate the extent of your coverage and the consistently useful presentation in our articles, regular features and your advertisements."

Peter R. Braginton, P. E.

Datatrol Company,
5526 Dyer St.,
Dallas 6, Tex.

". . . We find your magazine very informative and find this article ("The Dynamics of Relays," Nov. 1959) of particular interest to us in using and adapting commercial relays to our products."

G. C. Doehler,
Chief Engineer

Hevi-Duty Electric Co.
P. O. Box 563,
Milwaukee, Wis.

"Articles that appear in your magazine are interesting, informative and easily understood."

Roy S. Fisher,
Technical Asst.

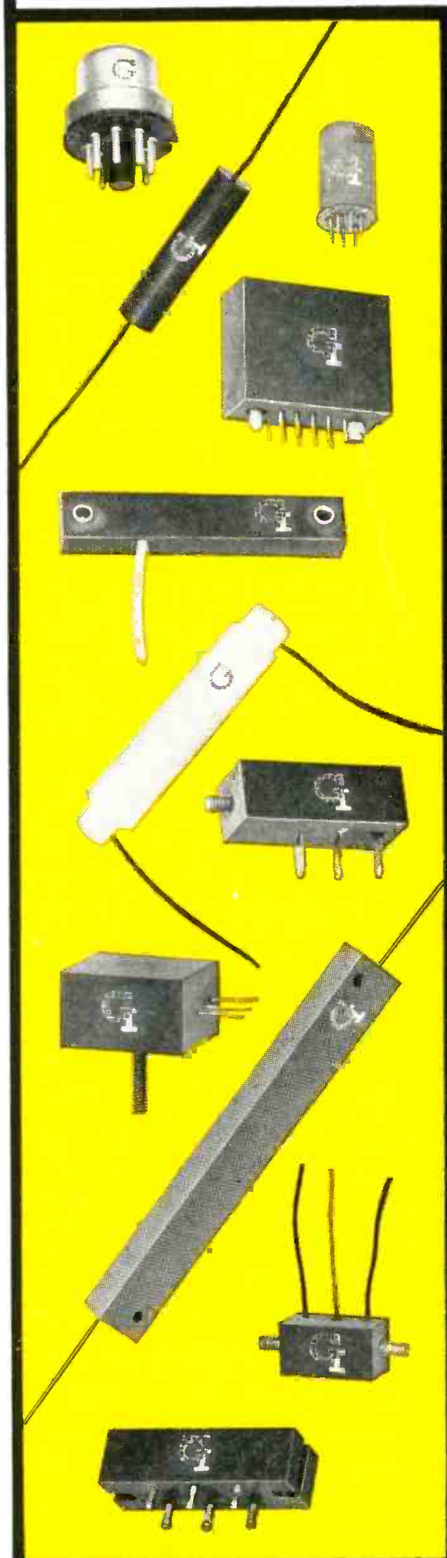
Western Electric Co.
Field Engineering Force,
White Sands Missile Range,
New Mexico

". . . Again, please accept my congratulations for another fine issue. . . . It has been of considerable value in my work. As a matter of fact I like to keep all my back issues intact for future reference, hence my request for reprints."

Steven Galagan,
Consulting Engineer

30 Whittier Rd.,
Wellesley Hills 81, Mass.

GENERAL INSTRUMENT SEMICONDUCTOR DIVISION



custom made to your needs

GENERAL INSTRUMENT

PACKAGED ASSEMBLIES

Silicon Rectifiers

Silicon and Germanium Diodes

in any shape... in any circuit configuration

Want semiconductors in a special package? General Instrument will make up AUTOMATIC rectifiers and Radio Receptor diodes in any packaged assembly needed to fit your specific requirements. Units can also include resistors, capacitors, etc. to produce complete circuit packages if you desire.

Let us accept the shrinkage and other technical problems — it's our business and we have the experience and facilities to do a superior job. Result will be a compact package virtually unlimited in PIV, with all the reliability General Instrument semiconductors are noted for. Total cost? Even less than if you developed your own package. Write or call today for further information.

Semiconductor Division
GENERAL INSTRUMENT CORPORATION
65 Gouverneur Street, Newark 4, N. J.

GENERAL INSTRUMENT CORPORATION INCLUDES F. W. SICKLES DIVISION, AUTOMATIC MANUFACTURING DIVISION, RADIO RECEPTOR CO., INC., MICAMOLD ELECTRONICS MANUFACTURING CORPORATION AND HARRIS TRANSDUCER CORPORATION (SUBSIDIARIES)

Books

Masers

By J. R. Singer. Published 1959 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 147 pages.

This is the first published study of quantum mechanical amplifiers. As such, summarizes years of research effort and provides a unified survey of maser devices.

The author approaches masers from both the classical and quantum mechanical points of view. He includes a description of the amonium maser and a theoretical discussion of a magnetic atomic beam system. After a short section on the optically pumped frequency standard, the book moves on to a discussion of electron paramagnetic resonance. Two-level masers are treated with emphasis on their possibilities for millimeter and submillimeter wave generation. Numerical illustrations are then employed in an examination of three-level cavity masers. The final chapter deals with the theory and experimental results of the traveling wave maser.

The appendices contain information on two important maser design techniques—the iso-frequency plotting and the multiple pumping methods.

Hypersonic Flow Theory

By Wallace D. Hayes and Ronald F. Probstein. Published 1959 by Academic Press, Inc., Publishers, 111 Fifth Ave., New York 3. 464 pages. Price $11.50.

In this book the authors have endeavored to present the fundamentals of the subject as they understand, together with a reasonably comprehensive report from the state of knowledge at the time. A book such as this is needed now, even though numerous refinements and extensions of the theory will certainly be made later.

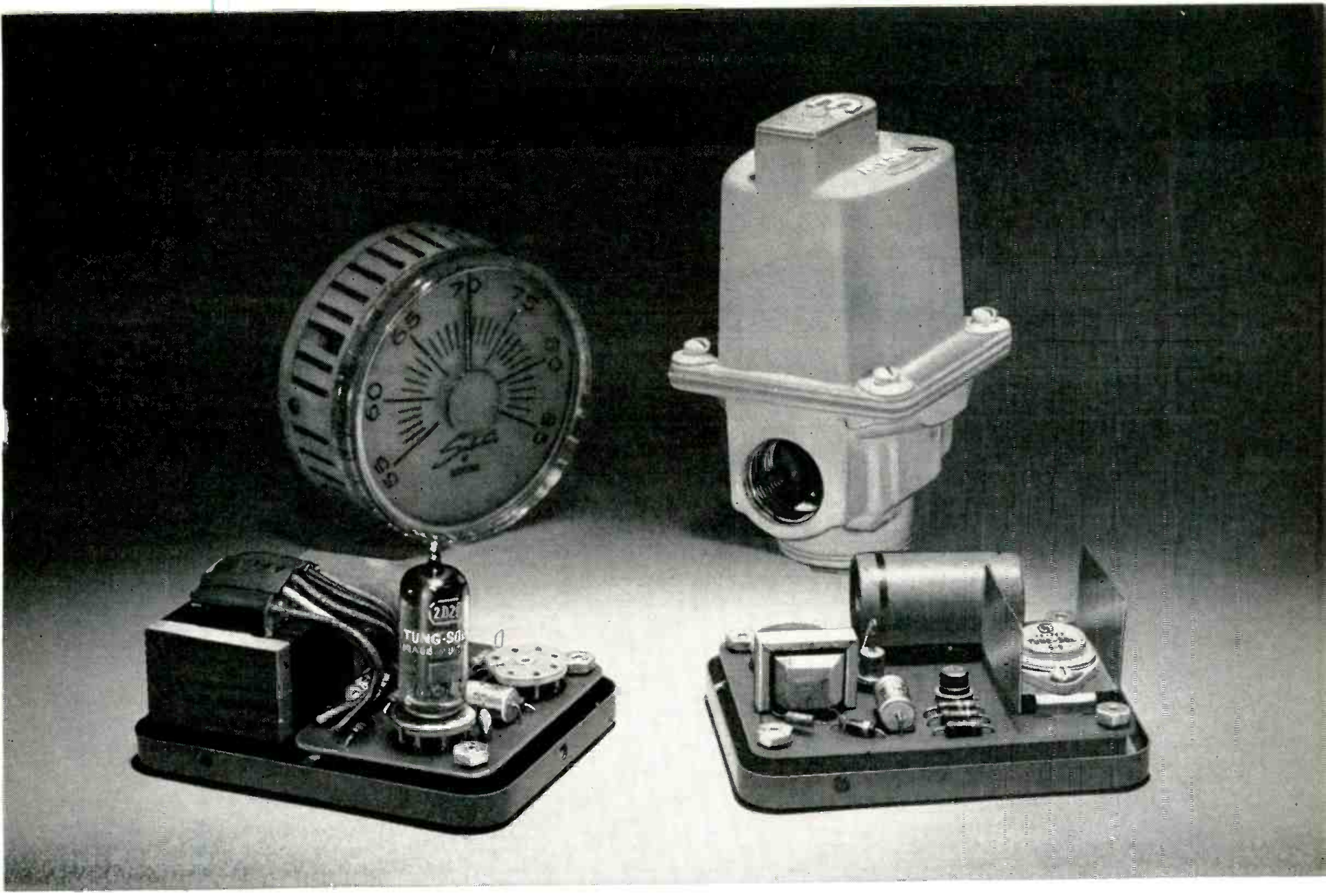
The book is directed to students and research workers in the field of modern gas dynamics, and to hypersonic aerodynamicists. It should also be of interest to scientists and engineers desiring some insight into this relatively new field.

Transistors in Radio, Television and Electronics, 2nd Edition

By Milton S. Kinver. Published 1959 by McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36. 424 pages. Price $7.95.

Radio, television, and electronics technicians will find complete information on the increasingly important field of transistors in this excellent reference book and guide. The important new material on this revision deals with transistors in electronic circuits and transistor amplifier design. Fundamentally, this book stresses the practical aspects of transistors and their operation. Generous illustrations, including perspective

(*Continued on page* 58)



End alternate chills and hot blasts. Shown in front of the thermistor wall unit and the furnace modulator valve are the tube type and transistorized amplifiers for the new Selectra home gas furnace control now in production at Maxitrol Company, Detroit, Michigan.

Tung-Sol tubes and transistors help MAXITROL provide non-cycling home heating

Maxitrol Company's new Selectra electronic gas furnace control does away with fluctuations in room temperature. It continually adjusts the burner flame to exactly compensate for the heat loss in the home and it responds to temperature changes as low as 1/10 degree F. Selectra controls are available with either tube type or transistorized amplifiers which boost the signal from a thermistor in the wall unit to selectively energize a solenoid in the furnace modulator valve.

Depending on their design some gas burners must be ignited at maximum flame. On such burners the tube type amplifier using a Tung-Sol 2D21 thyratron is recommended. The tube warm-up period provides a 10-15 second delay during which time the solenoid cannot be energized, insuring ignition at maximum flame.

Transistorized Selectra amplifiers are recommended for burners which can be successfully ignited at less than maximum flame. Since there is no warm-up delay with the transistorized circuit, ignition may occur as low as 1/3 of full fire. For this unit, Tung-Sol supplies TS757, a high power transistor selectively inspected to provide extremely tight characteristics. The high reliability of these Tung-Sol transistors, say Selectra's designers, was largely responsible for this type of control being in production.

Do you have an unusually demanding tube or transistor requirement? Tung-Sol applications engineers stand ready to help you. You'll get utmost benefit from their experience by consulting them while your equipment is in the planning stage. Just call or write: Tung-Sol Electric Inc., Newark 4, N. J. TWX:NK193

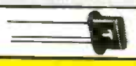
ts TUNG-SOL®

Circle 39 on Inquiry Card

Transitron offers...

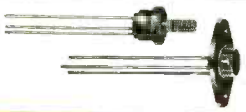
INDUSTRY'S MOST COMPLETE LINE

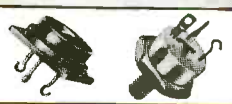
SILICON TRANSISTORS

JAN TRANSISTOR		Minimum Current Gain (B)	Maximum Collector Voltage (Volts)	Typical Cut-off Frequency (MC)	Maximum I_{co} @ 25°C and V_c Max. (μa)	FEATURES
	JAN-2N118	10	30	10	1	• Only Jan Silicon Transistor

SMALL SIGNAL		Minimum Current Gain (B)	Maximum Collector Voltage (Volts)	Typical Cut-off Frequency (MC)	Maximum I_{co} @ 25°C and V_c Max. (μa)	FEATURES
	2N333	18	45	7	50	• Low I_{co} • Operation to 175°C • 200 mw Power Dissipation
	2N335	37	45	10	50	
	2N480	40	45	11	.5	
	2N543	80	45	15	.5	
	ST905	36	30	10	10	

HIGH SPEED SWITCHING		Typical Cut-off Freq. (MC)	Maximum Collector Voltage (Volts)	Maximum Collection Saturation Resistance (ohms)	Max. Power Dissipation @ 100°C ambient (MW)	FEATURES
	2N1139	150	15	60	500	• High Frequency Operation • Low Saturation Resistance • Low I_{co}
	2N337	20	45	150	50	
	2N338	30	45	150	50	

MEDIUM POWER		Max. Power Dissipation @ 25°C Case (Watts)	Maximum Collector Voltage (Volts)	Minimum DC Current Gain (B)	Typical Rise Time (μsec)	Typical Fall Time (μsec)	FEATURES
	2N545	5	60	15	.3	.5	• Fast Switching • High V_c • Rugged Construction
	2N547	5	60	20			
	2N498	4	100	12			
	2N551	5	60	20			
	2N1140	3	40	20	.2	.1	

HIGH POWER		Maximum Power Dissipation . . 25°C Case (Watts)	Minimum DC Current Gain (B)	Typical Collector Saturation Resistance (Ohms)	Maximum Collector Voltage (Volts)	FEATURES
	ST400	85	15 @ 2 Amps	1.5	60	• High Current Handling Ability • Low Saturation Resistance • Rugged Construction
	2N389	85	12 @ 1 Amp	3.5	60	
	2N424	85	12 @ 1 Amp	6.0	80	

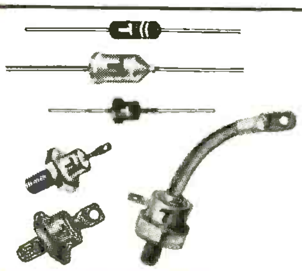
Write for Bulletins: TE-1353 and TE-1355

SILICON DIODES

	Fast Switching and High Frequency Types Ratings @ 25°C				Military and High Conductance Types Ratings @ 150°C			
FEATURES		Max. Inverse Voltage (Volts)	Max. Average Fwd. Current, (ma)	Inverse Recovery Time (μsec)		Max. Inverse Voltage (Volts)	Max. Average Fwd. Current (ma)	Max. Inverse Current (μa) @ V
• Recovery Times Under 15 μsec • High Conductance Combined With Fast Switching • Subminiature Size • High Inverse Resistance	1N808	100	100	.3	JAN 1N457	60	25	5 @ 60
	1N809	200	100	.3	JAN 1N458	125	25	5 @ 125
	1N658	120	200	.3	JAN 1N459	175	25	5 @ 175
	1N659	55	100	.3	1N485B	180	50	5 @ 175
	1N643	110	100	.3	1N488A	380	50	25 @ 380
	JAN 1N251	30	75	.15	1N464	175	40	30 @ 125

Write for Bulletin TE-1350

SILICON RECTIFIERS

Ratings @ 150°C Case Temperature			Peak Recurrent Inverse Voltage (Volts)	Maximum Average Forward Current (ma)	Maximum Inverse Current (ma)	FEATURES
	Subminiature Glass	1N689 1N649	600 600	150 150	0.2 0.2 (@ 25°C)	• Reliability at High Temperatures • High Efficiency • Rugged Construction • Hermetic Sealing • Low Thermal Resistance
	Miniature	TJ60A TJ30A	600 300	200 200	0.5 0.5	
	Axial Leads	SL715 1N547	1500 600	100 250	0.2 0.3	
	Military	JAN 1N256	570	200	0.25 (@ 135°C)	
	Stud Mounted	TM155 TM67	1500 600	400 3000	0.5 0.5	
	Medium Power	TR402 TR601	400 600	Amps 20 10	5 5	
	High Power	TH402B	400	50	15	

Write for Bulletin TE-1351

Books

(Continued from page 54)

diagrams, show the workings of transistors.

The author explains modern electron theory in simple terms, and shows exactly how point-contact, junction, and other transistors operate. He discusses transistor use in commercial radio receivers, television sets, and electronic installations, and he illustrates actual working circuits.

Property Measurements at High Temperatures

By W. D. Kingery. Published 1959 by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 416 pages. Price $16.50.

This book is intended for the reader who is involved or expects to be involved with the development or application of materials at unusually high temperatures. It concentrates on the factors effecting the properties or materials and their measurement at temperatures above 1400°C. All important high-temperature properties are discussed including heat induction and radiation, density and thermal expansion, strength, elasticity of solids, viscosity, electrical and magnetic properties, and surface energy. The author examines the most suitable method for determining each property at high temperatures and provides a basis for comparing various techniques for measurement. He also discusses the reliability and value of the available high-temperature literature.

Mathematics in Physics and Engineering

By J. Irving and N. Mullineux. Published 1959 by Academic Press Inc., Publisher, 111 Fifth Ave., New York 3. 883 pages. Price $11.50.

This work describes the analytical and numerical (desk calculator) methods which arise most frequently in present-day pure and applied science. The subject matter of the volume has formed the basis of lecture courses given to students of mathematics, physics, and engineering, at both undergraduate and graduate levels.

Emphasis is placed upon the application of the mathematical theory, and each topic is logically developed from first principles so that the reader with a good knowledge of elementary differential and integral calculus should be able to understand the theory and to work through the problems at the end of each chapter. Examples illustrating and extending the theory and its ramifications are drawn from various fields of pure and applied science, namely, elasticity, conduction of heat, hydrodynamics, For Capacitors with GREATER RELIABILITY . . .

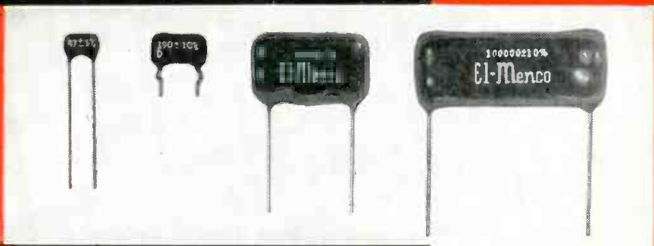
Choose **El-Menco**

The Capacitors You Find Wherever There's Electronics!

EL-MENCO DUR-MICA CAPACITORS

Only 1 Failure Per 43,000,000 Unit-Hours!

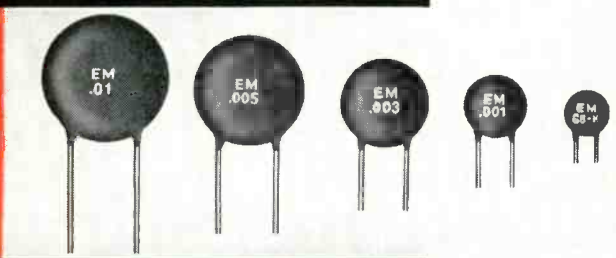
- It has been computed that "debugged" DM30, 10,000 MMF units, when subjected to 257,000 hours of life at 85°C with 100% of the rated DC voltage applied, will yield only 1 FAILURE PER 43,000,000 UNIT-HOURS!
- DM15, DM16, DM19, DM20 . . . perfect for miniaturization and for new designs using printed wiring circuits. Also available in DM30, DM42 and DM43.
- New "hairpin" parallel leads insure easy application.
- Exceed all electrical requirements of military specification MIL-C-5A.



EL-MENCO CERAMIC DISC CAPACITORS

Toughest Ever!

- Available in 500 working volts DC and 1,000 working volts DC ratings.
- Low-loss phenolic coating that is wax impregnated.
- Flat design assures reduced self-inductance . . . particularly adaptable to very high frequency applications.
- Insulation resistance far exceeds the 10,000 megohms minimum requirement.
- Exceed all electrical requirements of E.I.A. specifications RS-198.

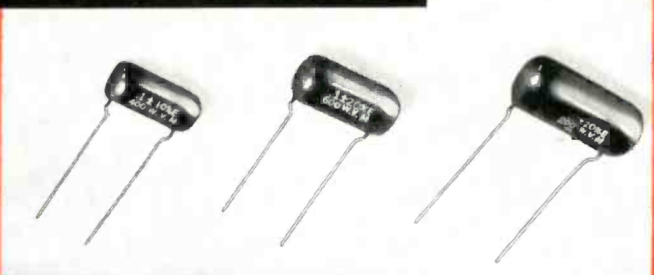


EL-MENCO *MYLAR-PAPER DIPPED CAPACITORS

Only 1 Failure in 7,168,000 Unit-Hours!

- Life tests at 100°C with rated voltage applied have yielding only 1 FAILURE PER 716,800 UNIT-HOURS for 1 MFD. Since the number of unit-hours of these capacitors is inversely proportional to the capacitance, 0.1 MFD Mylar-Paper Dipped capacitors will yield only 1 FAILURE PER 7,168,000 UNIT-HOURS!
- Working volts DC: 200, 400, 600, 1000 and 1600.
- Durez phenolic resin impregnated.
- Tolerances: ± 10% and ±20% (closer tolerances available).
- Dielectric strength: 2 or 2½ times rated voltage, depending upon working voltage.
- Exceed all electrical requirements of E.I.A. specification RS-164 and military specifications MIL-C-91A and MIL-C-25A.

*Registered Trademark of DuPont Co.

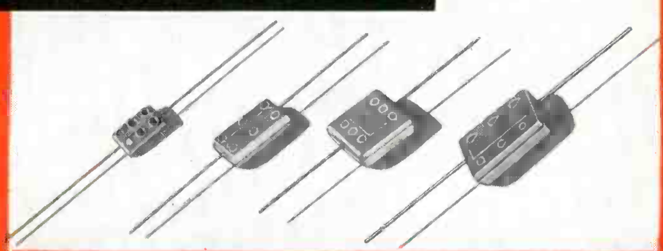


EL-MENCO MOLDED MICA CAPACITORS

Superior Performance!

- Unmatched for excellent stability, dielectric strength, high insulation resistance, extremely high "Q" and correspondingly low power factor.
- Units can be subjected to a short "debugging" life test at elevated voltage and temperature for removal of early life failures and for improved reliability.

Write for Free Samples and Booklets on Any of The Above Capacitors



El-Menco *Capacitors*

EL-MENCO OFFERS A COMPLETE LINE OF CAPACITORS . . . STANDS READY TO SERVE ALL YOUR CAPACITOR NEEDS.

THE ELECTRO MOTIVE MFG. CO., INC.

Manufacturers of El-Menco Capacitors

WILLIMANTIC CONNECTICUT

• molded mica • dipped mica • mica trimmer • dipped paper • tubular paper • ceramic • silvered mica films • ceramic discs

Arco Electronics, Inc., 64 White St., New York 13, N. Y.
Exclusive Supplier To Jobbers and Distributors in the U.S. and Canada

Books

(*Continued from page 58*)

electrostatics, wave propagation, supersonic flow, classical and wave mechanics.

Radio Engineering Handbook, 5th Edition

Edited by Keith Henney. Published 1959 by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 6. 1775 pages. Price $25.00.

Radio engineering problems can be solved more quickly, easily, and accurately with the aid of the modern data and practice given in this revised edition. Here—the designers, engineers, and technicians—are working principles, standards, and procedures that mean quick answers to both routine and special assignments in radio engineering.

Communications, broadcasting, aircraft radio, television, facsimile, navigation aids, telephony—these and other major radio fields are covered in practical, easy-reference form.

Both fundamentals and specialized applications are discussed—covering resistance, inductance, waveguides and cavity resinators, loudspeakers, transmitters and receivers, and many other aspects of radio.

Books Received

On Mathematics and Mathematicians

By Robert Edouard Moritz. Published 1959 by Dover Publications, Inc., 180 Varick St., New York 14. 410 pages, paper bound. Price $1.95.

TV and Film Production Data Book

By Ernest M. Pittaro. Published 1959 by Morgan and Morgan Inc., 101 Park Ave., New York 17. 448 pages. Price $6.95.

Forging

Published 1959 by Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, Calif. 336 pages. This book is available at no charge when requested on company letterhead. A charge of $7.50 per copy is made for personal library copies.

The Philosophy of Space and Time

By Hans Reichenbach. Published 1959 by Dover Publications, Inc., 180 Varick St., New York 14. 295 pages, paper back. Price $2.00.

Printed Circuits

By Morris Moses. Published 1959 by Gernsbach Library, Inc., 154 W. 14th St., New York 11. 224 pages, paper back. Price $2.90.

Photo Tubes

Edited by Dr. A. Schure. Published 1959 by John F. Rider Publisher, Inc., 116 W. 14th St., New York 11. 96 pages, paper back. Price $1.80.

Philosophy and the Physicists

By L. Susan Stebbing. Published 1959 by Dover Publications Inc., 180 Varick St., New York 14. 295 pages, paper back. Price $1.65.

True Position Dimensioning

By D. Bibeau and D. Sweet. Published 1959 by Bendix Aviation Corp., Scintilla Div., Sidney, N. Y. 28 pages, paper bound. Price $3.00 per copy in lots of 1 to 10; $2.50 per copy in lots of 10 or more.

2N697 MULTI-PURPOSE SILICON 'MESAS' NOW MASS-PRODUCED BY WORLD'S LARGEST TRANSISTOR MANUFACTURER

MEDIUM-POWER AMPLIFIERS • SMALL-SIGNAL AMPLIFIERS • SWITCHERS

FEATURE:

- Diffused-base 'mesa' construction
- 2-w maximum power dissipation at 25°C
- DC betas of 20-60 and 40-120

ACTUAL SIZE

Available now in production quantities . . . TI 2N696 and TI 2N697 multi-purpose silicon 'mesa' units for amplifier, switching and medium-power applications.

Produced by the pioneer of the diffused-base process, these highly reliable 'mesa' units feature . . . *2-w maximum power dissipation . . . beta spreads of 20-60 (TI 2N696) and 40-120 (TI 2N697) . . . 10-ohm maximum saturation resistance.*

Your full-year guarantee is backed by TI's proven production capabilities (largest in the world and currently being doubled) and a stringent quality assurance program.

Check these specs and contact your nearest distributor or TI sales office for *immediate* delivery.

electrical characteristics at 25°C ambient

(unless otherwise noted)

	PARAMETERS	TEST CONDITIONS		min.	max.	unit
I_{CBO}	Collector Reverse Current	V_{CB} = 30v	I_E = 0	—	1.0	μa
	at 150°C	V_{CB} = 30v	I_E = 0	—	100	μa
BV_{CBO}	Collector-Base Breakdown Voltage	I_{CBO} = 100μa	I_E = 0	60	—	v
BV_{CER}	Collector-Emitter Breakdown Voltage	I_{CER} = 100ma	R_{BE} = 10 ohms	40	—	v
BV_{EBO}	Emitter-Base Breakdown Voltage	I_{EBO} = 100μa	I_C = 0	5	—	v
h_{FE}*	D-C Forward Current Transfer Ratio	I_C = 150ma	V_{CE} = 10 v (2N696)	20	60	—
			(2N697)	40	120	—
V_{BE} (sat)*	Base-Emitter Saturation Voltage	I_C = 150ma	I_B = 15ma	—	1.3	v
V_{CE} (sat)*	Collector-Emitter Saturation Voltage	I_C = 150ma	I_B = 15ma	—	1.5	v
h_{fe}	A-C Common Emitter Forward Current Transfer Ratio	I_C = 50ma	V_C = 10v f = 20mc	2.5	—	—
C_{ob}	Collector Capacitance	I_E – 0ma	V_C = 10v	—	35	μμf

*Pulse conditions: length=300μs ; duty cycle∠2%.

maximum ratings at 25°C ambient

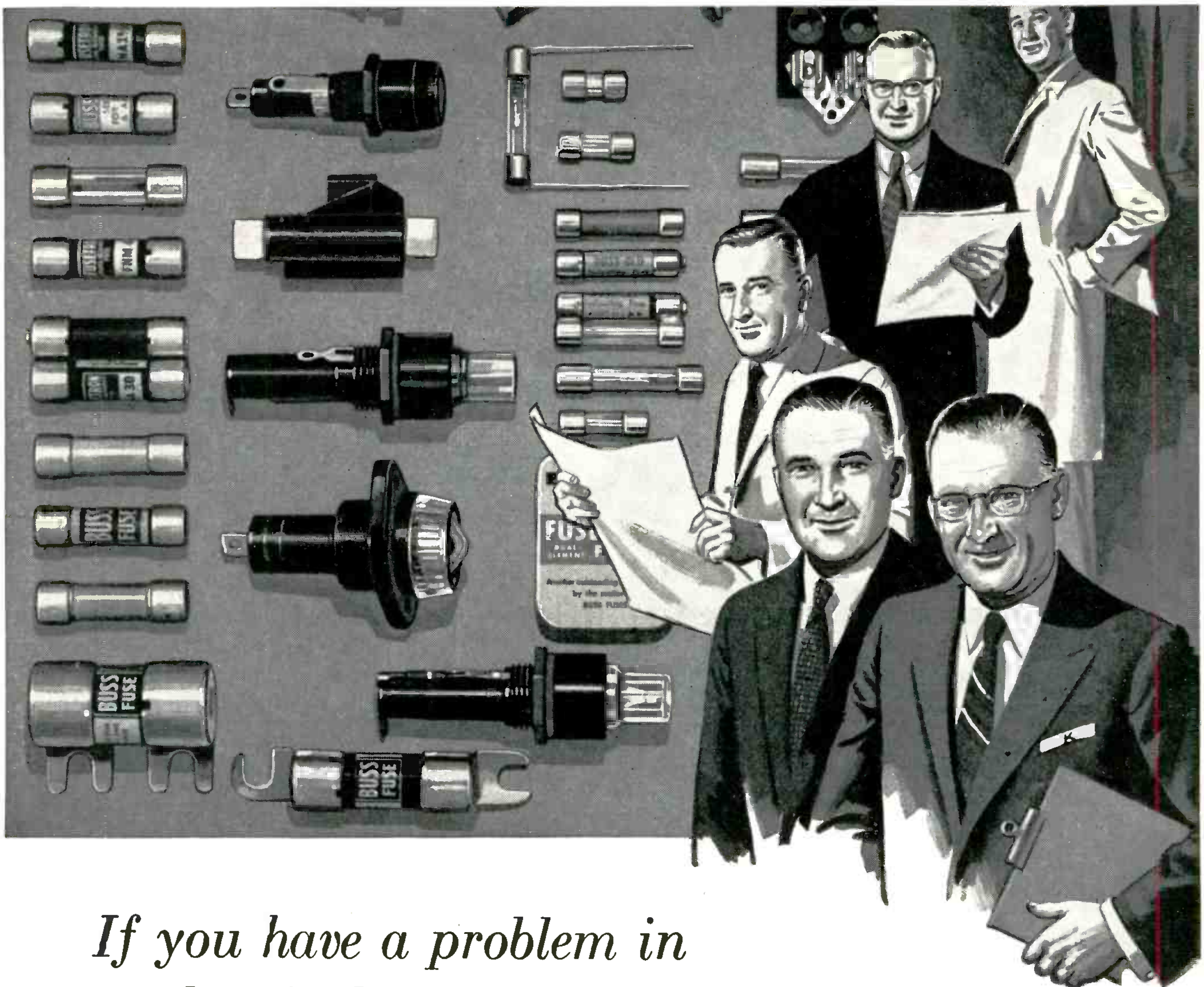
Collector-Base Voltage	60v
Collector-Emitter Voltage (R_{BE} = 10 Ω)	40v
Emitter-Base Voltage	5v
Total Device Dissipation	0.6w
Total Device Dissipation at case temperature 25°C	2w
Storage Temperature Range	–65°C to +175°C

INSTRUMENTS
INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
13500 N. CENTRAL EXPRESSWAY
POST OFFICE BOX 312 • DALLAS, TEXAS

Write on your company letterhead describing your application for specific details on TI products.

Circle 44 on Inquiry Card

Transistors / Diodes / Resistors / Rectifiers / Capacitors



If you have a problem in electrical protection — let BUSS Fuse Engineers Help You Solve It.

If you have an electrical protection problem, the BUSS fuse research laboratory, and its staff of engineers are *at your service.* Our engineers will work with yours to help you find a solution — and so save you engineering time.

It is quite possible a fuse already stocked by local wholesalers will be your answer, so that the right fuse is readily available if your equipment needs service.

The complete BUSS and FUSETRON fuse line includes:

Single-element fuses for circuits where quick-blowing is needed, such as for instrument protection.

Single-element fuses for normal circuit protection.

Dual-element, slow-blowing fuses for circuits where harmless current surges occur.

Indicating fuses where signal must be given when fuses open — or to activate an alarm.

BUSS and FUSETRON fuses range in size from 1/500 amperes up — and there's a companion BUSS line of fuse clips, blocks and holders.

Dependability Always

Every BUSS or FUSETRON fuse is tested in a sensitive electronic device that automatically rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

For a catalog on BUSS and FUSETRON small dimension fuses and fuseholders, — write for bulletin SFB. If you need special fuses or fuseholders, submit description or sketch, showing type of fuse to be used, number of circuits, type of terminal, etc.

BUSSMANN MFG. DIVISION,
McGraw-Edison Co.
University at Jefferson, St. Louis 7, Mo.

1259

BUSS fuses are made to protect - not to blow, needlessly.

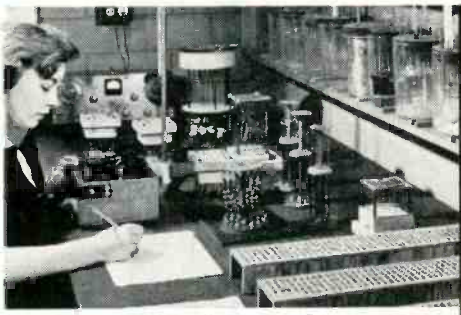
BUSS makes a complete line of fuses for home, farm, commercial, electronic, electrical, automotive and industrial use.

FUSETRON — TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION — BUSS | McGRAW EDISON

Circle 36 on Inquiry Card

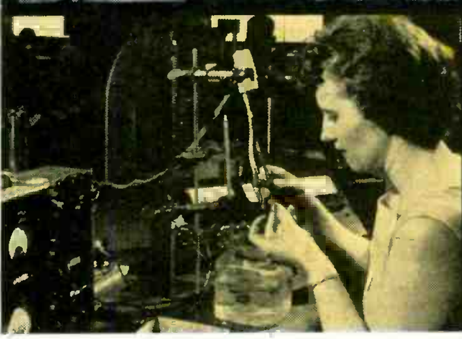
Circle 37 on Inquiry Card →

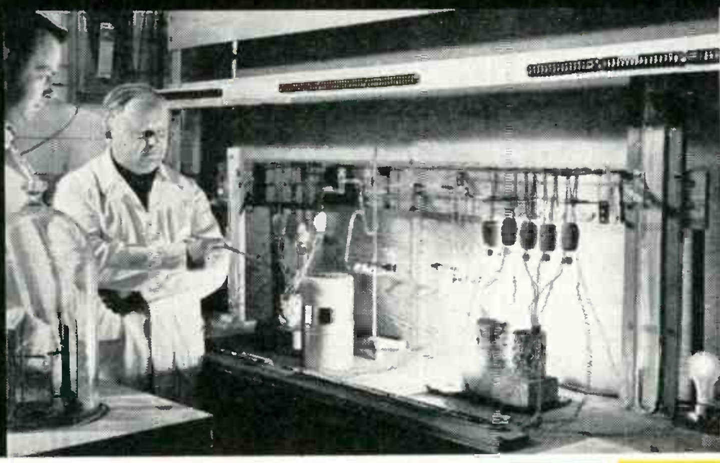
The CARE that produces QUALITY in THERMISTORS

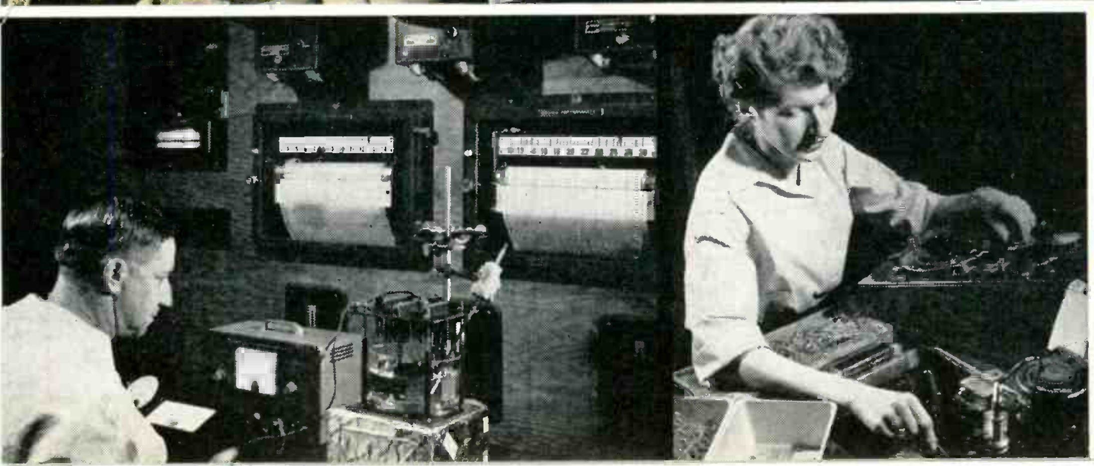


Besides the technology and manufacturing resources you'd expect of Keystone, there's a great deal of individual patience and care bound up in each thermistor we make. Our Thermistor Division is staffed by people who appreciate the importance of precision workmanship—and many of them have been with us since we made our first negative temperature coefficient resistance unit over 20 years ago. ● Along with our complete laboratory, engineering and manufacturing facilities, our "people who care" have made Keystone *the key name* in thermistors today.

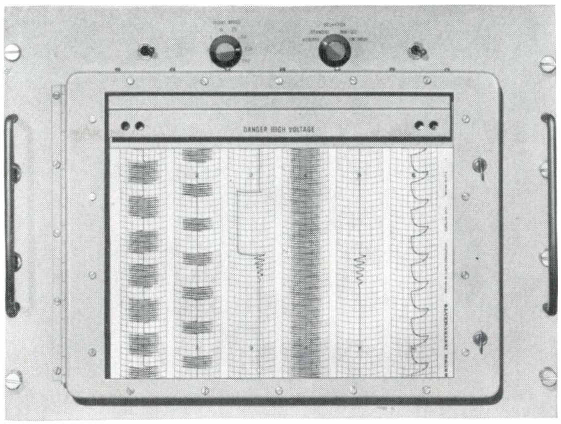
How do you benefit by all this? It's simple. Whether the thermistor you need is as large as your thumb or as small as a gnat's eye, it will perform as specified . . . on earth, in space, or below the seas . . . if made by the people at Keystone. ● We'd be more than pleased to hear from you about your possible application for thermistors. Chances are we can help. Write us.

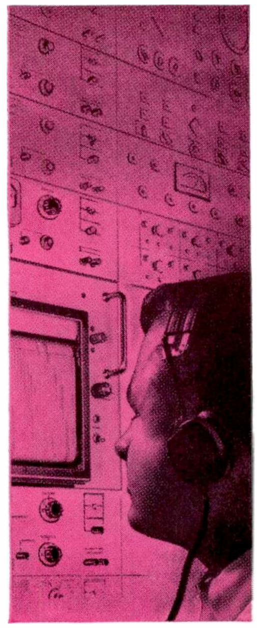


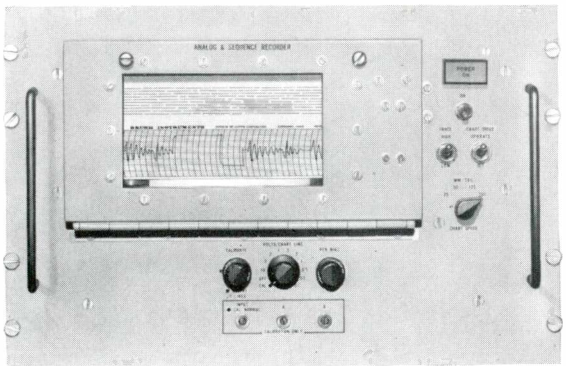


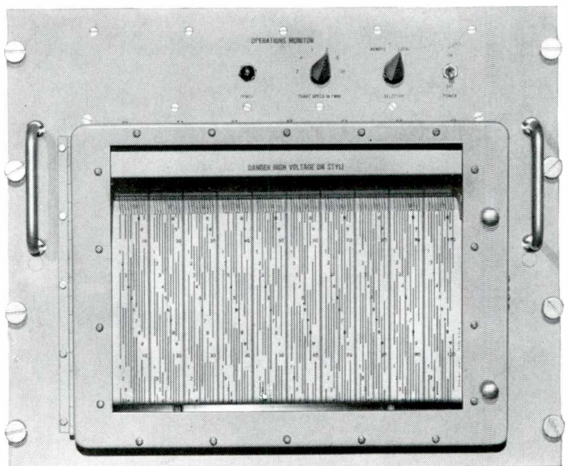


Keystone
CARBON COMPANY
Thermistor Division
ST. MARYS, PA.









in direct writing recording systems

only Brush designs specifically for mil specs

From every nut and bolt to the shipping crate, fully militarized Brush Direct Writing Recording Systems are *originally* built to meet military specifications.

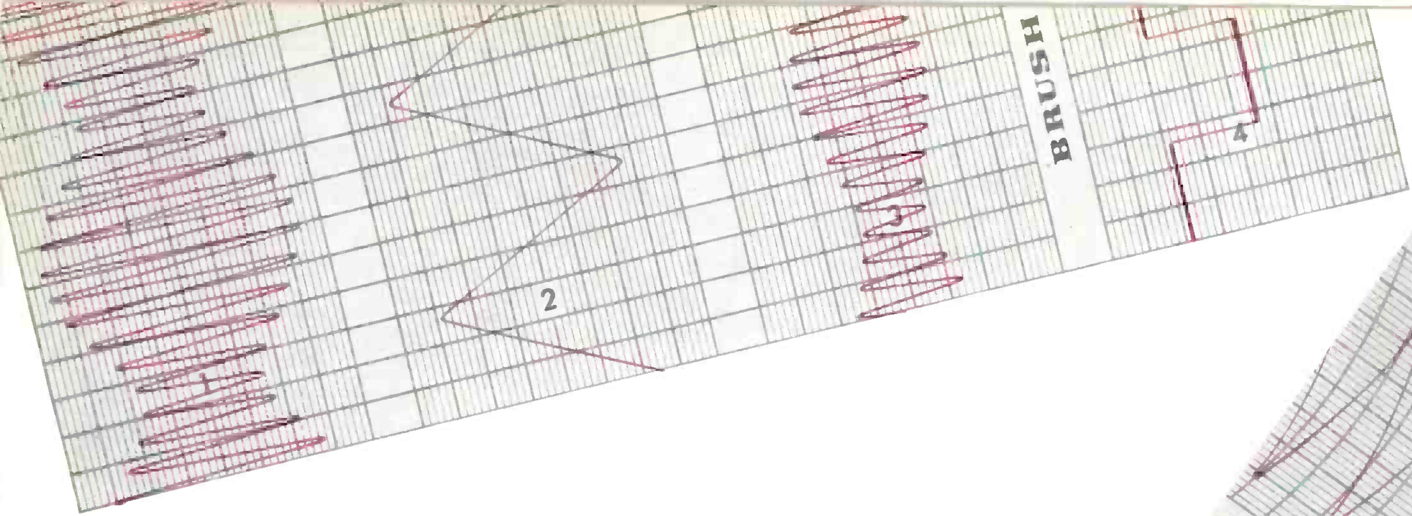
That's why they are performing every imaginable task of data acquisition and recording at U. S. and NATO installations throughout the world. These electric writing systems have proved their unexcelled reliability . . . from the Operations Monitor that will record 120 separate operations at the instant they occur . . . to the Analog and Sequence Recorder that simultaneously records both analog data and sequential events. And, they are built for maximum performance in the hands of non-technical personnel.

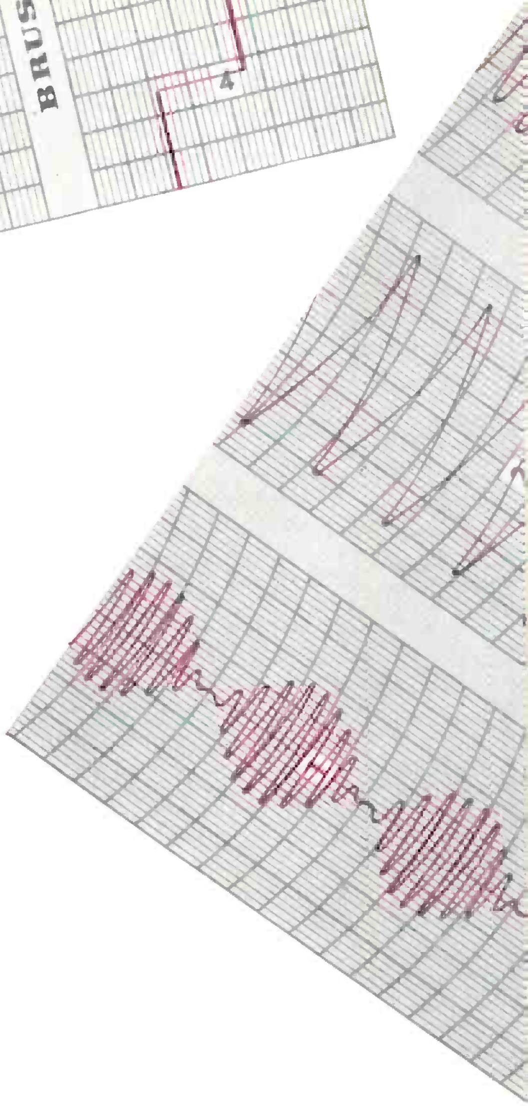
Brush equipment is already at work putting evaluation data in writing for a whole new generation of weapons. When the weapons become operational, Brush MIL Recorders are a vital part of the system. This experience is unique in the industry. *Before* prototype design becomes a problem—call, write or wire Brush for complete details.

brush INSTRUMENTS

DIVISION OF

37TH AND PERKINS CLEVITE CORPORATION CLEVELAND 14, OHIO





in chart paper

there is a difference

brush INSTRUMENTS
DIVISION OF CLEVITE CORPORATION
37TH AND PERKINS CLEVELAND 14, OHIO

Only Brush Chart Paper is designed as an integral component of precisely engineered Brush Direct Writing Recording Systems. The full potential of these systems cannot be realized unless *all* of the original components are utilized. They're engineered as a *total* entity. Imitation papers cannot match the precision ruling, dimensional stability and super-smoothness of Brush Chart Paper. Take no chances—specify *Brush* and you can rely on your records being accurate, permanent, easily read and easily reproduced. Stocks available from strategically located branches and sales representatives throughout the United States and Canada.

Write for samples of actual tracings on Brush Chart Paper. Ask for "Check the Record".

Next month

● SEMICONDUCTOR SYMBOLS

A new staff-prepared chart containing a complete listing of all symbols pertinent to semiconductors which have been adopted as standard by the Institute of Radio Engineers. Included will be definitions for electrical quantities and parameters, letter symbols in alphabetical order, graphical symbols and device symbols.

● ANNUAL REVIEW AND FORECAST FOR THE ELECTRONIC INDUSTRIES

A statistical review of what has been produced. Clues to new or expanding electronic markets. A valuable annual feature for year-round reference use.

● NOMOGRAPHS FOR MODIFYING ELECTRON TUBE DIMENSIONS

Three nomographs make it possible to determine quickly the physical tube dimensions required to provide certain electrical characteristics provided the dimensions and electrical characteristics of a tube of the same general class are already known.

Plus all our 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, Rep News, International Electronic Sources, Personals, Industry News, etc.

COMING SOON:

● HUMAN FACTORS AND ELECTRONIC ENGINEERING

Space horizons call for complex electronic equipment. In another exclusive editorial staff study EI investigates the abilities of the human-users. Many companies have organized human factor "teams." Read this report for details on this and other work now being done in this field.

● SPECIAL PURPOSE CATHODE RAY TUBES

Another in EI's series of Special Staff Reports. The cathode ray tube has found scores of applications beyond those most commonly thought of . . . oscilloscopes and picture tubes. Here's the story on many new applications and a thorough treatment of the engineering of tubes to meet new technical specifications from the glass and phosphor to the electron gun.

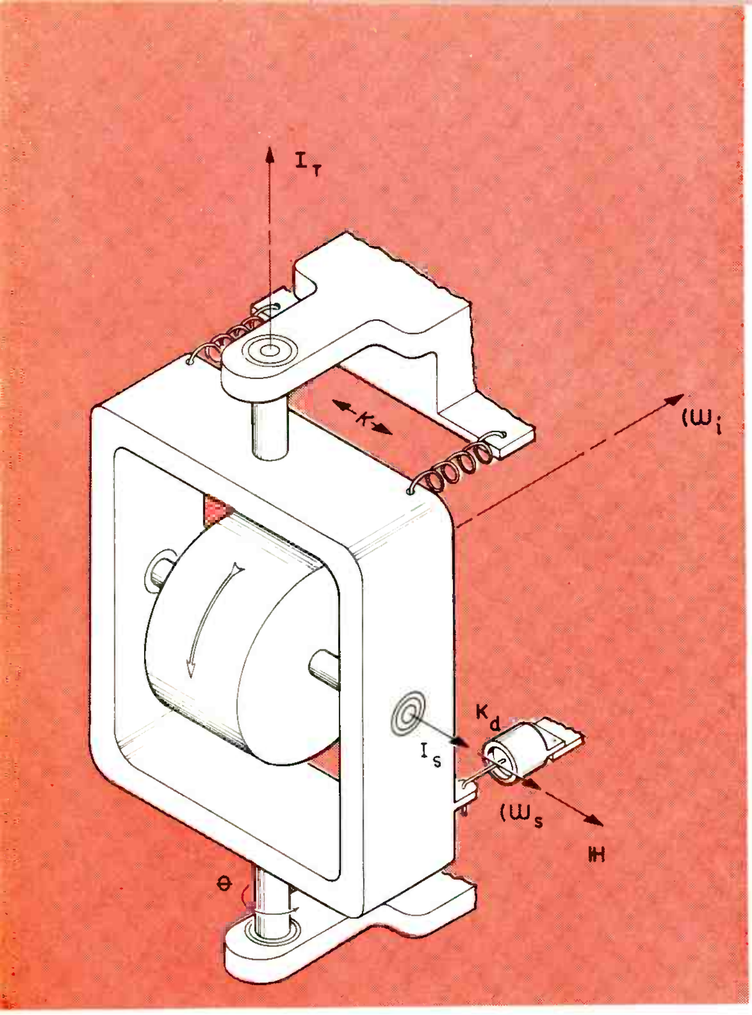
Watch for these coming issues

*JANUARY
Industry Review

*MARCH
Annual IRE Issue

*APRIL
Space Electronic Issue

*JUNE • 18th Annual Directory & All Reference Issue



THE RATE GYRO

Fig. 1: Schematic representation of a rate gyro. Symbols are identified in Table 1.

BASICALLY, the rate gyro, or "angular rate of rotation transducer" is a simple device. However, its basic simplicity becomes lost as realistic considerations supplant over-simplified assumptions, and as stringent quantitative demands are placed on its performance.

The sudden appearance of a complex situation where a simple one was assumed to exist can prove embarrassing to the system engineer and the instrument designer alike, as many individuals can testify. This article presents some of the more complex relationships and considerations which apply to typical rate gyro transducers. It is hoped that this compilation of information will be of use to designers and users of this type of instrument.

The simple rate gyro is basically a transducer responsive to angular rate about a particular (input) axis. The primary output is an angular deflection about another axis perpendicular to the input axis. The transfer function is achieved by means of a gyroscope, spinning in the rotating gimbal, with its angular momentum vector mutually perpendicular to the input and output axes.

Linear, centering, spring restraint is provided between the frame and moving gimbal, and damping is generally provided to minimize overshoot and resonance. The output motion may be utilized directly, as in the turn indicator, or may be converted to an electrical or hydraulic signal by an output transducer.

Fig. 1 and Table 1 define the terms and symbols.

Static Inputs

Assuming θ to be small, then a given rate input would, in steady state, imply an equal rate of gyro precession. This must be accounted for by a torque according to the law

$$\dot{\mathbf{H}} = \mathbf{L}$$

where $\dot{\mathbf{H}}$ represents the vector rate of change of angular momentum, and $\mathbf{L}$ the applied precessing torque, obtained from spring deflection.

Thus, since H is assumed constant,

$$L = \omega_i H$$

but

$$L = K\theta$$

thus

$$K\theta = \omega_i H$$

and

$$\theta = \frac{\omega_i H}{K} \qquad (1)$$

but

$$\alpha = \frac{\theta}{\omega_i} \quad \text{(by definition)}$$

or

$$\theta = \alpha\omega_i$$

then

$$\alpha = \frac{H}{K} \qquad (2)$$

Dynamic Inputs

Now, it is generally assumed that the rate gyro will perform, about its output axis, as a simple mass spring system with viscous damping, and as defined by the normal, second order differential equation:

$$I_t\ddot{\theta} + K_d\dot{\theta} + K\theta = L \qquad (3)$$

For such a system, then,

$$f_n = \frac{1}{2\pi}\sqrt{\frac{K}{I_t}} \qquad (4)$$

but

$$M = \frac{I_s}{I_t}$$

thus

$$f_n = \frac{1}{2\pi}\sqrt{\frac{KM}{I_s}} \qquad (5)$$

Substituting, from Eq. (2),

$$f_n = \frac{1}{2\pi}\sqrt{\frac{\frac{H}{\alpha}M}{I_s}}$$

$$f_n = \frac{1}{2\pi}\sqrt{\frac{I_s\omega_s M}{I_s\alpha}}$$

The rate gyro is an important component of most missile and aircraft control systems. Its dynamic response characteristics are important in proper selection. Here these properties are treated from the designers viewpoint.

Interrelations—

Perturbations in Behavior

By C. E. BARKALOW
Manager, Advance Engineering Div., Instrument Division, Lear, Inc. Grand Rapids, Mich.

thus

$$f_n = \frac{1}{2\pi}\sqrt{\frac{\omega_s M}{\alpha}} \qquad (6)$$

also

$$R = \frac{I_t}{I_s \omega_s}$$

or

$$R = \frac{1}{M \omega_s}$$

Substituting, in Eq. (6)

$$f_n = \frac{1}{2\pi}\sqrt{\frac{1}{R\alpha}} \qquad (7)$$

The damped natural frequency is given by

$$f_{n,d} = \frac{1}{2\pi}\sqrt{\frac{K}{I_t} - \left(\frac{K_d}{2I_t}\right)^2} \qquad (8)$$

For critical damping

$$K_{d.c} = 2\sqrt{K I_t} \qquad (9)$$

or

$$K_{d.c} = 4\pi\, I_t f_n \qquad (10)$$

For steady state, sinusoidal input, where

$$\psi = A \sin \omega t$$

$$L = (A\omega H) \cos \omega t$$

and

$$\theta = B \sin (\omega t + \tau),$$

$$B = \frac{A\omega H}{\sqrt{(K - \omega^2 I_t)^2 + \omega^2 K_d^2}} \qquad (11)$$

and, for $\omega^2 I_T << K$, and $K^2 << \omega^2 K_d^2$

$$B \cong \frac{A\omega H}{\omega K_d}$$

or

$$B \cong \frac{AH}{K_d} \qquad (12)$$

Also, where

$$AR = \frac{B}{\dfrac{A\omega H}{K}}$$

$$AR = \frac{K}{\sqrt{(K - \omega^2 I_T)^2 + \omega^2 K_d^2}} \qquad (13)$$

For $\omega^2 I << K$

$$AR = \frac{K}{\sqrt{K^2 + \omega^2 K_d^2}} \qquad (14)$$

Useful dynamic response curves relating amplitude and phase angle of output with steady state sinusoidal forcing function input are shown in Fig. 3.

Perturbations from Ideal Performance

There are many causes for perturbation from the ideal transducer behavior. Some of the more common ones are merely listed in Table 2 in hopes that they may serve a useful purpose in planning, evalu-

Table 1

Symbol	*Definition*	*Units*
I_s	Spin moment of inertia	gm cm^2
H	Gyro angular momentum	gm cm^2/sec.
ω_s	Gyro angular velocity	[radians]/sec.
I_t	Transverse moment of inertia. about output axis	gm cm^2
ω_i	Input rate of rotation	[radians]/sec.
ψ	Angular rotation about input axis	[radians]
θ	Angular deflection of gimbal relative to frame	[radians]
K	Angular spring restraint	$\frac{\text{dyne cm}}{\text{[radian]}}$ or gm cm^2/sec^2
f_n	Undamped natural frequency, about output axis	(cycles)/sec. or sec.$^{-1}$
f_{nd}	Damped natural frequency, about output axis	(cycles)/sec. or sec.$^{-1}$
α	Angular response sensitivity (compliance)	$\frac{\text{(rad)}}{\text{(rad)/sec.}}$ or sec.
M	Inertia ratio figure of merit $\left(\frac{I_s}{I_t}\right)$	Dimensionless
R	Characteristic time constant, $\frac{I_t}{H}$	Sec.
K_d	Damping constant	$\frac{\text{gm cm}^2}{\text{sec.}}$
K_{dc}	Damping constant for critical damping	$\frac{\text{gm cm}^2}{\text{sec.}}$
L	Torque, applied to gimbal, along output axis	$\frac{\text{gm cm}^2}{\text{sec.}^2}$

Rate Gyros *(Continued)*

ating, and utilizing this type of equipment. They are not listed in any particular order of significance. The relative seriousness of any one possible trouble is, of course, dependent on design approach, and system requirements. They are categorized generally in accordance with the entry point of the basic perturbance to the transducer system. The list is by no means complete, and deals generally with the less obvious type of disturbance eliminating from the discussion, for example, such problems as gimbal bearing friction (stiction), effects of non-iso elasticity and imbalance of gyro and gimbal supports under vibration and acceleration, temperature effects on sensitivity, damping, and dimensional stability, etc.

"Crosstalk" effect

Ideally, a rate gyro would be responsive only to inputs along its case defined input axis. The axis of insensitivity is, however, always aligned with the spin axis. When the gimbal is displaced, then, due to an input rate, a rotational component introduced along the normally insensitive axis will affect the output. This effect is known as "cross talk." It is usually expressed in percent of input sensitivity at maximum input (maximum gimbal deflection). The magnitude of the effect is somewhat direction sensitive. That is, for one direction of rotation it will *increase* the deflection, thus augmenting the "cross talk" effect, while in the opposite direction it reduces the deflection, thus diminishing the effect.

Table 2

Causes for Perturbation

POINT OF ENTRY	BASIC PROBLEM	HOW EVIDENCED	REMARKS
Gimbal centering restraint	Hysteresis	Failure to repeat output for given input, when approached from opposing directions of input.	This is generally a materials and mechanical design problem in spring centered rate gyros. By using selected materials and by designing to limit stress to < approximately 50% of "yield" this effect can be reduced to < ± 0.1% of full scale output "at stops".
	Lack of radial symmetry in spring restraint, coupled with radial looseness in gimbal support.	Apparent gimbal "unbalance" even with actually balanced gimbal.	If a single simple spring-arm centering is assumed, with a moment arm of 3/4 in., a typical apparent unbalance effect of ± 0.1% of full scale will result with a radial looseness of only 0.000025 in.
Damping	Damping non-linear with angular velocity.	In dynamic testing, amplitude ratio dependent on forcing amplitude; or displacement of resonant peak as function of forcing amplitude; etc.	Usually associated with fluid damping mechanisms based on the principal of mass flow. In some cases, variations in K_d of ± 20% may be typical. Generally this is not too serious except in especially demanding applications.
	Coupling looseness	Low amplitude "noise" due to lack of damping within looseness of mechanism.	Typical of certain damping mechanism designs wherein mechanical linkages are used. These might be associated with temperature control mechanisms, "connecting rod" pivots to damping pistons, etc. Can be troublesome as a noise producer at amplitudes in the order of ± 1.0% of full scale.
	Damping with gas dash-pot.	Very poor dynamic compliance with second order equation.	In this case, not only is the damping force non-linear with steady state velocity, but due to compression of the gas, another variable, spring term is introduced. Not suitable except for very crude applications.
Mechanical design of gyro wheel and gimbal structure	Mechanical uncertainties in defining a unique and rigid output axis.	Poor compliance with second order equation in dynamic response. Low f_n when tested under dynamic conditions. Poor transient response. Noise, and modulation of output.	This type of problem can be caused by several factors, and can be very troublesome. For example, in designs where the gyro rotor is spun on a shaft, flexure of this shaft under the high-level torques associated with dynamic inputs can occur. Flexure of gimbal axis trunnions, or looseness in gimbal bearings are other typical sources of this type of trouble. Another very common source of trouble is in designs wherein spool type torsion bars are utilized to provide gimbal axis restraint and definition. Lateral softness of this type of gimbal axis constraint can have appreciable effect on dynamic response.
Basic mechanics	"Cross-talk"	Sensitivity to inputs about axes other than the defined "input" axis.	Described in text.

In Fig. 2, conditions have been chosen to produce the maximum effect. $\omega_{i,x}$ is the rotation velocity about the input axis. $\omega_{i,y}$ is the component along the normally insensitive axis. The vector sum is the total instantaneous rate of rotation of the rate gyro.

Ideally,

$$\theta = \alpha\omega_{i,x}$$

Actually,

$$\theta' = \alpha\omega_{i,x} \cos \theta' + \alpha\omega_{i,y} \sin \theta'$$

For small angles

$$\theta' = \alpha\omega_{i,x} + \alpha\omega_{i,y}\, \theta'$$

$$\theta' = \frac{\alpha\omega_{i,x}}{1 - \alpha\omega_{i,y}}$$

In the limit, as $\alpha \rightarrow 0$, it can be seen that $\theta' \rightarrow \theta$. Thus, to minimize "cross talk", higher values of angular spring restraint (lower angular response) are needed.

Let $\epsilon = \theta' - \theta$

Cross talk sensitivity, S is then defined by the following relationship:

$$S = \frac{\epsilon}{\frac{\omega_{i,y}}{\alpha}} \times 100$$

$$\frac{\frac{\alpha\omega_{i,x}}{1 - \alpha\omega_{i,y}} - \alpha\omega_{i,x}}{\alpha\omega_{i,y}} \times 100$$

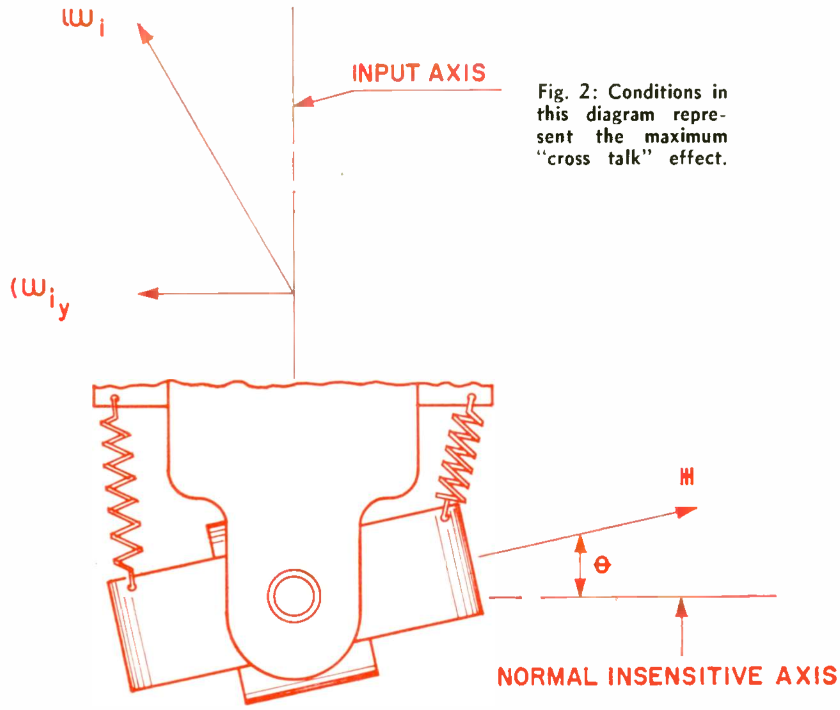


Fig. 2: Conditions in this diagram represent the maximum "cross talk" effect.

$$= \frac{1}{\alpha\omega_{i,y}} \cdot \frac{\alpha\omega_{i,x} - \alpha\omega_{i,x} + \alpha^2\omega_{i,x}\,\omega_{i,y}}{1 - \alpha\omega_{i,y}} \times 100$$

$$S = \frac{\alpha\omega_{i,x}}{1 - \alpha\omega_{i,y}} \times 100 \qquad (15)$$

Example

For a rate gyro which displaces 1.0° for an input of 12°/sec. at max. rate,

$$\alpha = 1/12 = 0.083 \text{ sec.}$$

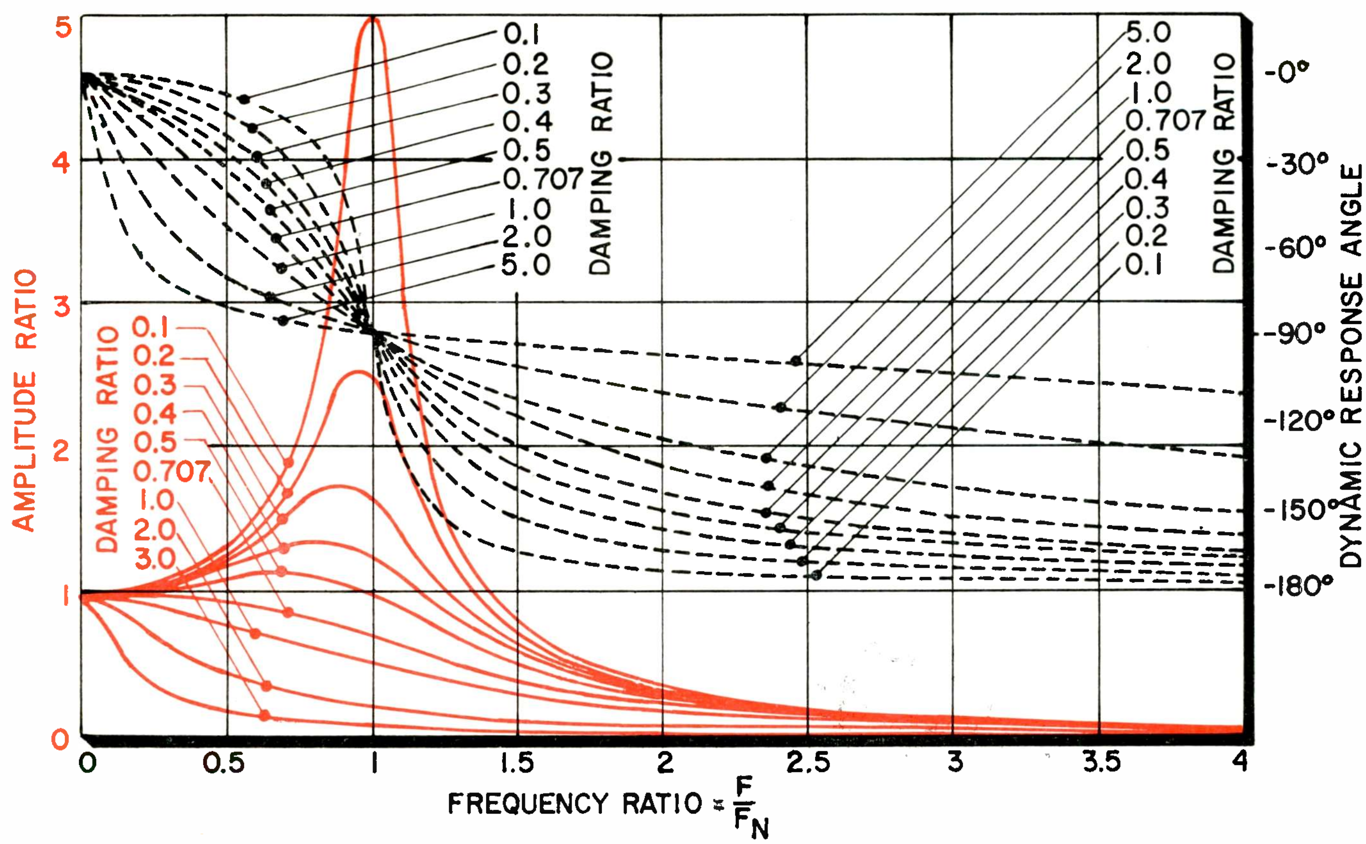
For $\omega_{i,y} = \omega_{i,x} = 12.0°/\text{sec.} = 0.21$ rad/sec.

$$S = \frac{0.083 \times 0.21}{1 - 0.083 \times 0.21} \times 100$$

$$= \frac{0.0174 \times 100}{1 - 0.0174} = \frac{1.74}{0.9826} = 1.77\%$$

* * *

Fig. 3: Steady—state sinusoidal response characteristics associated with Eq. 3.



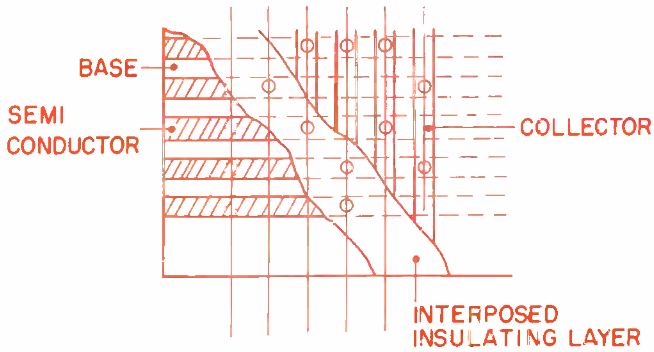
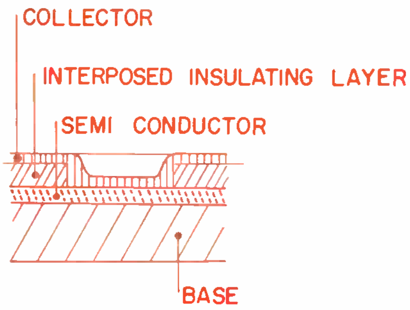


Fig. 1a (left): Layer Structure of the printed diode matrix.

Fig. 1b (right): Cross section through a single diode junction.



Compact matrices of low cost and high reliability are one of the most powerful building elements in data handling systems. To accomplish this, printed circuit techniques are contemplated for manufacturing these compact diode or resistor networks. Progress and state of the art are given here.

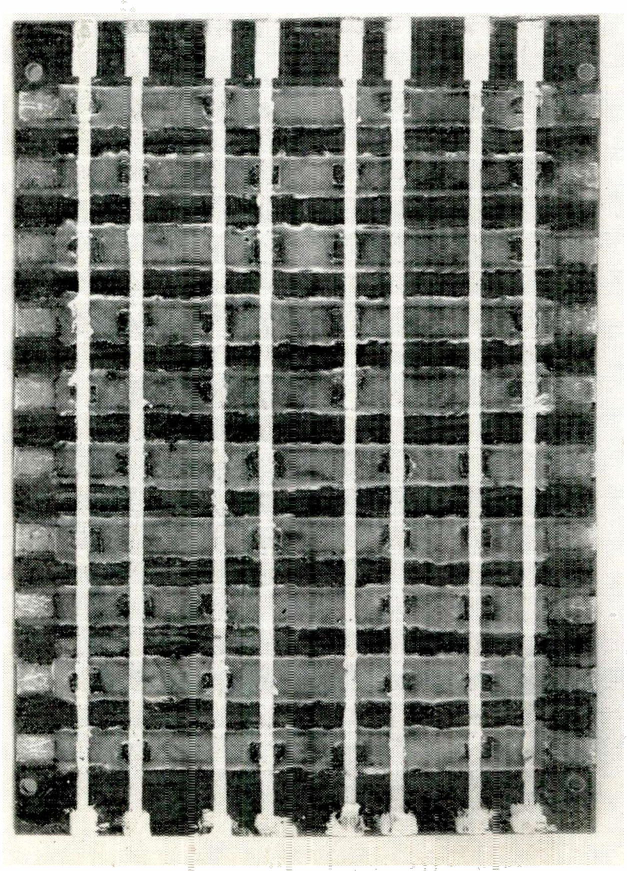
For Data Handling Systems . . .

Printed Diode and Resistor

Part One of Two Parts

By Dr. E. J. SCHUBERT
Burroughs Research Center
Paoli, Pa.

Fig. 1c: Photograph shows a prototype of printed diode matrix



THE use of printed circuit techniques is contemplated for manufacturing compact diode or resistor networks. Deposited diode networks with a density of 16 junctions per square inch exhibit a remarkable current capacity to operate directly between magnetic registers with 3 db cut-off near 250 KC. Resistor matrices comprise a diode in each decoder channel and a single stage transistor amplifier in each output line. Due to the audio transistor 2N105 the cut-off frequency was 33 KC for an input signal of 6 volt into a translator network from 5 bit-code to a 35-bit word.

With both techniques densities of up to 64 junctions per square inch appear to be feasible.

1 THE NEED FOR PERMANENT STORAGE

The evolution of digital techniques in the field of integrated data processing requires linkages between remote sub-systems, as well as input and output devices which may use different machine languages or codes. Automatic operation of such non-uniform sub-systems demands uni- or bi-lateral code transla-

Since preparing this article, Dr. Schubert has relocated. He is now Technical Director with Monitor Systems, Inc., a subsidiary of Epsco, Inc., located in Ft. Washington Industrial Park, Ft. Washington, Pa.

tion. Similarly, certain input and output devices utilized in office automation exhibit patterns of high redundancy for character recognition in readers or character formation in printers, making it necessary to translate binary words of up to 63 bits into ordinary 6-bit codes and vice versa.

Because of time limitations, most of these functions require combinational logic. Minimization of combinational logic has sometimes been emphasized to the extent that proper relation between less expensive logical elements and costly pulse restoring amplifiers becomes unbalanced. With advanced manufacturing techniques of integral logical networks, the cost per logical element has decreased. Accordingly a novel approach to the logical design appears justified with a more generous allowance for redundancies.

Based on this modified point of view, logical nets in the form of matrices may be constructed to con-

Matrices

Dr. E. J. Schubert

form directly with the pattern of ONE's and ZERO's in complete truth tables or digital function tables f(x) wherein x is the addressing argument. Any minimization may be restricted to eliminate irrelevant variables at the matrix inputs.[1]

Somewhat incorrectly, all kinds of networks representing truth tables or function tables of higher complexity are designated as "matrices."

Immediate applications for this concept and for the related hardware are anticipated in business computers for binary-coded-decimal adders and fixed subroutines or microprograms selected from exterior controls and advanced by suitable counters. Digital functions useful in business computers are income tax deductions for payrolls as a function of two variables, freight rates and coding of invoices. In control computers, significant reductions in operating time and cost are feasible by providing either logarithmic tables or special function tables.[2] Both groups of machines require a few fixed programs which need not be subject to frequent changes. These fixed programs may be conveniently provided in permanent storage devices of reasonable size, with a capacity of up to several hundred words.

State of the Art

Any logical function may be represented by two level nets preferably of the AND-OR type. However,

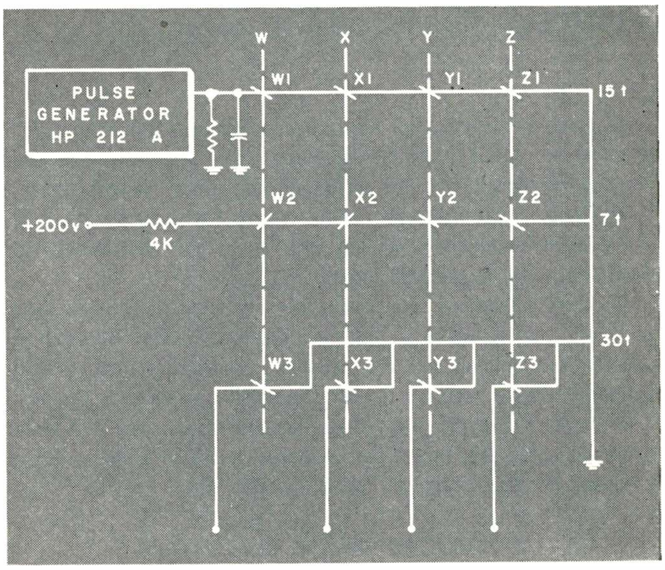


Fig. 2: Drawing shows magnetic drivers for diode matrix input

for multiple outputs of higher complexity, general matrices comprising essentially a decoder and an encoder section begin to be more economical. The decoder in such two level networks is a set of AND gates or equivalent complements and the encoder a set of buffers. Boolean algebra becomes inferior and impractical for the design of such matrices as the complexity increases; eventually matrix algebra must be substituted.[3]

Several direct access storage devices are known at the present to perform the required logical functions. However, all have limitations. Magnetic coincidence core memories have destructive readout or require high frequency interrogation. Cryotrons and Williams CRT storage are both volatile storage media. Flying spot scanning of dot patterns implies digital-analog conversion for decoding. Wired logic, which is just another form of storage, becomes excessive in cost for larger matrices with any type of logical element. Contrasted to these known techniques, permanent storage devices should have little attenuation between decoder input and encoder output. DC coupling would be desirable to permit freedom in the

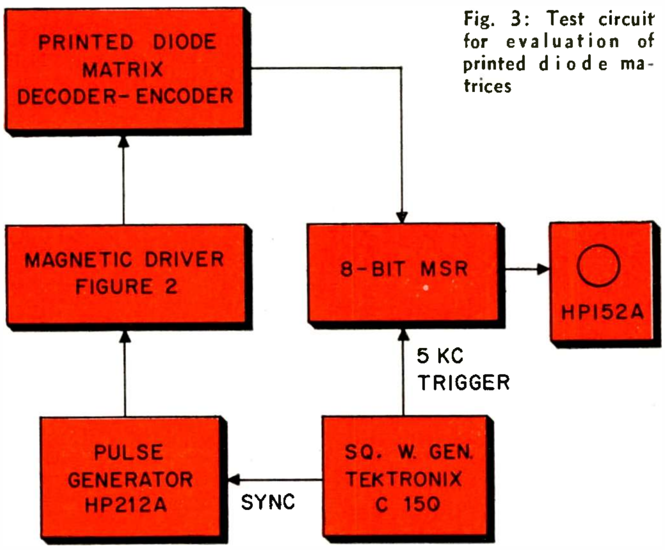


Fig. 3: Test circuit for evaluation of printed diode matrices

choice of synchronous or asynchronous circuits within the limits of the time constants. Readout must be non-destructive and available without resetting or rewriting. Eventually the manufacturing should allow standard nets which can be easily adjusted to perform any specified logic.

In the following sections, two different approaches toward permanent storage devices are described which are close to the desired specifications. The printed diode matrix is an entirely passive network with high current carrying capabilities. Its counter part is a printed resistor matrix with a single stage transistor amplifier in each output line.

2 PRINTED DIODE MATRICES

Diode matrices are extensively used in digital systems, either as logical nets or for storage of permanent information. The latter application is restricted to decoder-encoder matrices of limited size.

Besides conventional wiring, several assembly techniques have been considered already to interconnect diodes in large numbers.[4] In an English computer built at Birkbeck College[5] diode assemblies have been used successfully with the diodes mounted in perforated plates under spring load. Welded lattices of diodes with a density of 128/cu. inch have been reported elsewhere.[6] All these methods require precision machining to close tolerances with excessive cost for manual assembling.

Diode matrices comprising a decoder and an encoder section offer the unique advantage of little attenuation compared with other storage devices. The input signal applied to a diode matrix is reduced by the threshold voltage at each junction in the path of the signal. Parallel to the junction some capacitive bypass will be significant with increasing frequency. Accordingly it may be expected that large diode matrices will be limited due to capacitive shunts causing a relatively high noise level at the pulse edges. This limitation might be of lesser significance in asynchronous systems operating with pulses of longer duration than the clocked signals of synchronous systems. Digital communication generally has lower speed requirements for code translators which can be easily met with such diode matrices.

The novel component described below is an integral diode matrix without individual diodes. Printed circuit techniques are appropriately modified to obtain a two-level diode network directly from a single semiconductive layer instead of assembling individual diodes into a net.

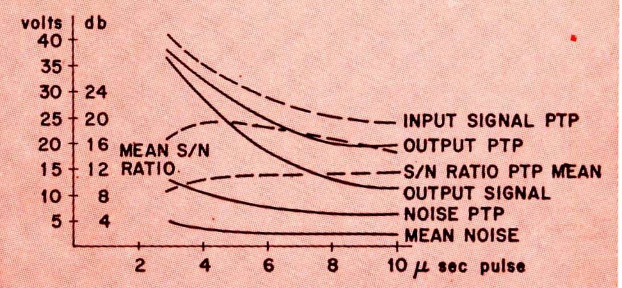


Fig. 4: Graph shows threshold signals of printed diode matrix for operating magnetic shift register

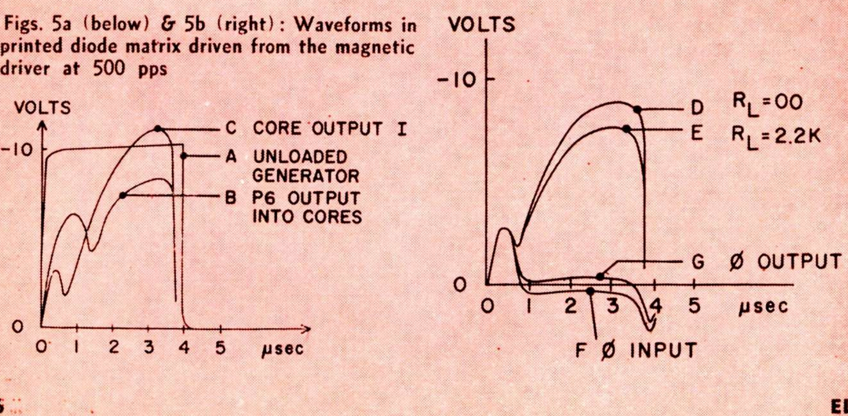
The Technique

Printed diode matrices may be produced in several ways, according to the original concept. One preferred method is a hot die stamp process in which aluminum foil is bonded to one or both sides of a special thermo-plastic sheet without the use of any adhesive agent. In this die-stamping, a pattern of parallel metal strips is formed, connected by bars or a frame on the periphery (Fig. 1). The aluminum is a special alloy that will chemically etch and nickel plate. Undercut etching serves as an improved bonding for the subsequent layers. Purpose of the nickel plating is a controlled crystal growth and orientation in the selenium layer. High purity selenium is evaporated over the nickel plated base plate in a thin layer and subjected to a peculiar temperature cycle for formation of crystals from the previously amorphous modification. Temperature control during this crystallization process is exceedingly critical and affects the behavior of the barrier layer. This barrier layer exhibits the nonlinear voltage current characteristic which is eventually utilized in the diode junction. Variations of the process permit the increase of the blocking or reverse voltage rating of the barrier layer or semiconductor bars.

A thin layer of insulation is applied on top of the semiconductor bars either in the form of a hot bonded thermoplastic sheet with a given pattern of perforations or by spraying or screen printing certain resins. After proper thermosetting of the insulation, a low melting point alloy is sprayed on in parallel strips but perpendicular to the semiconductor bars. These alloys range in melting temperature from 100° to 175°C; higher melting metals may be substituted if evaporation techniques are used.

The matrix assembly is virutally complete at this stage and will operate efficiently for approximately 10 volts reverse voltage. To increase the blocking voltages, the diode junctions have to be aged or electroformed by applying currents in the reverse direction.

Figs. 5a (below) & 5b (right): Waveforms in printed diode matrix driven from the magnetic driver at 500 pps



The diode matrices can be treated in certain emulsions and resinous solutions to withstand long periodic exposures to critical evironmental conditions.

Appropriate modifications of the process have been considered including etching of metal foil clad insulating materials or resilient prongs forming the collectors and protruding through perforations of an interposed sheet.

Evaluation of Prototypes

Prototype matrices were manufactured with a density of 16 junctions/sq. inch. Tentative experiments indicate that up to 64 junctions/sq. inch may be feasible. Performance tests of the diode matrices were conducted with pulse, sine and square wave inputs. In later tests the matrices were connected in multilevel logic and were driven from magnetic cores.

The outputs from the matrix were loaded either with pure resistors or magnetic shift registers. Voltage waveforms and setting conditions of the magnetic register were used as the criteria for the matrix performance.

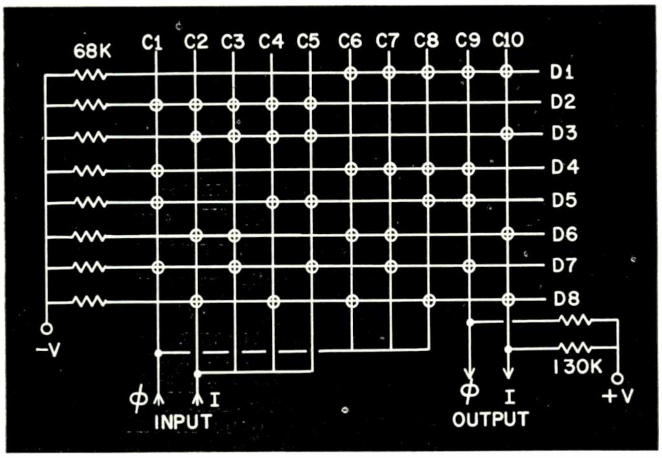


Fig. 6a: A decoder-encoder matrix pattern that was tested

The investigation was limited in particular to:

(a) Static decoder output from switch controlled pulse sources.

(b) Prototype matrices 8 by 10 for positive signals and 8 by 3 for negative signals.

(c) Performance tests with up to 10 μsecs at 500 pps.

Pulses from a high impedance source such as standard computer packages (transistorized) were distorted by the matrix load. No attempt was made to match the inverter amplifiers to the matrix load by means of emitter followers.

In the circuit, Fig. 2, a magnetic core driver controlled the pulses into the matrix. The output of the pulse generator was sloped at the leading edge, hence reducing noise. This noise designated the spikes at the matrix output due to the shuttle voltage passing through cut-off diode junctions as capacitive current. All windings drove towards state "0." DC bias through windings 2 held the cores W, X in state "1" but maintains the cores Y, Z in state "0." In windings 3 of the cores W, X substantial voltages were developed when switched to "0." The relatively small voltage induced in the output windings 3 of cores Y, Z were the noise appearing at the unselected columns of the matrix.

Magnetic Core Driver

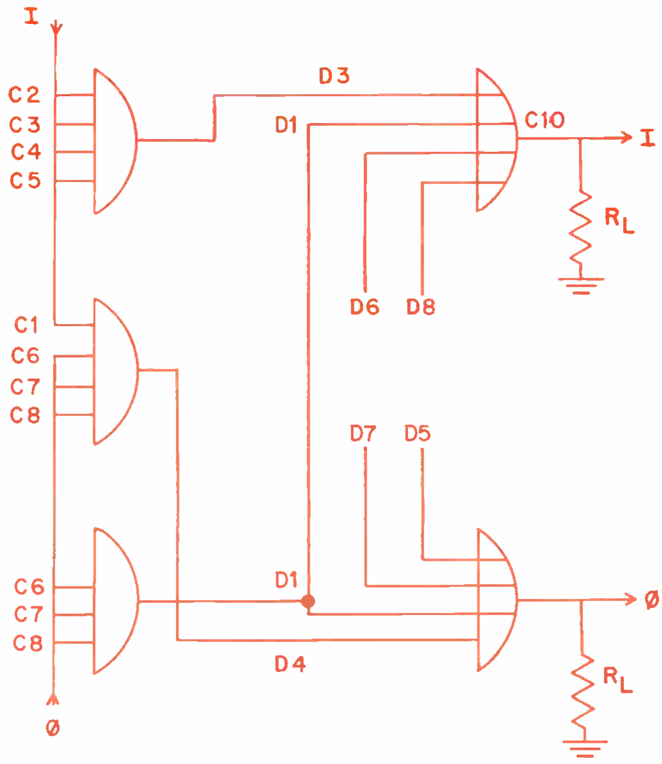
Fig. 3 shows the test circuit to evaluate a printed matrix in single level logic. For a diode rated at 1 ma. and an input of 10 volts, a gate resistor with 68 K and a bias potential of 48 volts was chosen. A shift register Magni-research SP5 was used as the load of the matrix. It required 25 ma. for 2 μsec. through a 2.2 K buffering resistor. A 2.2 K resistor actually overloads the gate, but the considerable shunt capacitance of the diodes permitted large current pulses. This effect was used to partially overcome the mismatch between matrix and load at the price of 40% loss in amplitude.

Signal noise ratios were determined for various pulse durations with the selected output adjusted to the threshold of the register.

Fig. 4 shows various voltages and voltage time integrals as required for code translation between magnetic registers. Figs. 5a and 5b show typical voltage waveforms of 4 μsec. pulses. The upper trace A is the generator output without load; the second trace B shows the same output but with the matrix load. Comparing the waveforms at the inputs and outputs of the matrix indicates that the leading and trailing edges of the pulses pass through the cut-off diodes due to the shunt capacitance of the junction. Relative to these transients, the dc leakage appears negligible.

It should be noted that the peak amplitude of the noise corresponds in time to the rise time of the input signal. During this preliminary investigation this rise time was not modified. Hence, no reduction of peak noise was attempted. Spurious setting of the

Fig. 6b: Logical diagram equivalent to matrix in Fig. 6a



Printed Matrices *(Continued)*

register was not observed for pulse durations of at least 4 μsec.

Sine Wave Input

For evaluation with sine wave signals of 50 to 500 KC, the balanced output from an audio oscillator HP 233A was connected to the matrix. At 500 KC the sine wave was severely distorted to a S/N ratio of approximately 1.5 to 1.0 compared with 5 below 275 KC.

The output signal showed some clipping around the negative peaks with an amplitude of approximately 70% of the input signal and distinct discrimination between selected and unselected channels.

Performance of Cascaded Matrices

For practical applications it is desirable to form complete logical nets in a single matrix without intermediate amplifiers. In general, any two level networks are suitable to represent any logical function. Such an approach might be even more acceptable if the logical nets are inexpensive.

A typical decoder-encoder matrix was tested in a configuration as illustrated in Figs. 6a and 6b. Circuit parameters were $R_{AND} = 68$ K ohm, $R_{OR} = 130$ K ohm, bias potential ± 45 volts.

Diode bars D1 to D8 were connected to the 68 K resistors to form gates for negative pulses from the "1" input.

Either ground or shuttle voltage from a magnetic driver were applied at the "0" inputs. Potentials at the diode bars were clamped to the most positive input as in conventional diode gates. The same diode bars acted also as inputs into buffers formed by the collector strips C9 and C10 which are connected to positive bias via 130 K.

For low source impedances the "0" output of the matrix was approximately 1.0 v. Waveforms obtained were similar to single level logic except that the peak amplitude of "0" outputs was reduced by slower rise and fall times.

A logic with redundant inputs according to Fig. 7a was tested with three printed diode gates in cascade. The output was unloaded, gate and buffer bias resistors were the same as in Fig. 6a. An input signal of —10 v/0 v was applied through a source impedance of 100 ohms.

Typical results for time constants were in the order of 50 μsec for two cascaded gates and 90 μsec for 3 cascaded gate circuits. S/N ratios between 6.5 to 24 db depend primarily on the circuit configuration.

Summary of the Evaluation

Printed diode matrices are characterized by a capacitance in the order of 6500 μμf/cm^2 of junction area. At higher frequency this capacitance shunts the cut-off diode and imposes a low impedance load on the source. Therefore the waveforms of the signal source may be considerably distorted by the matrix with little difference between input and output waveforms. At low duty cycle, advantage may be taken of the matrix capacitance to develop signals across a load resistance lower than possible with capacity free diodes. Under the limited scope of this evaluation, S/N ratios of 10 db were obtained for peak voltages and 20 db for voltage time integrals. Two level logic integrated in a single matrix gave results similar to single level logic. Cascaded matrices in multilevel logic in excess of two levels could not operate at speeds above 4 KC since attenuations are multiplicative.

Satisfactory S/N ratios may be obtained with printed diode matrices similar to the prototype for binary signals providing the signal has no frequency components above 250 KC.

A specific feature of this novel component is the low impedance which offers advantageous applications between magnetic registers at input and output without intermediate amplifiers between decoder and encoder section.

(Continued next month)

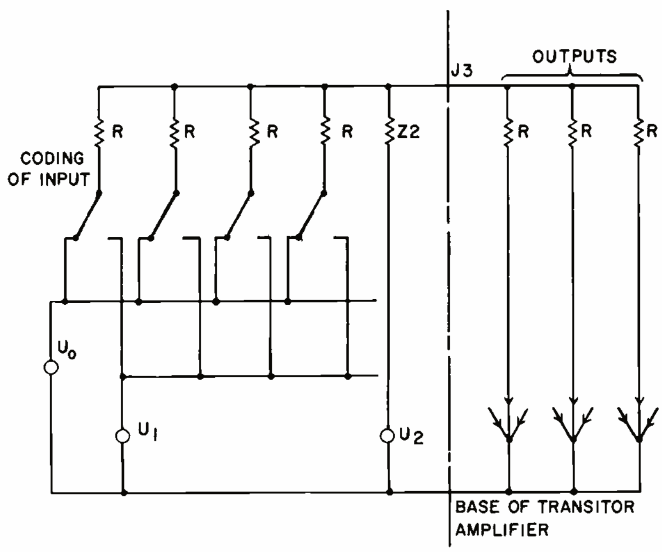
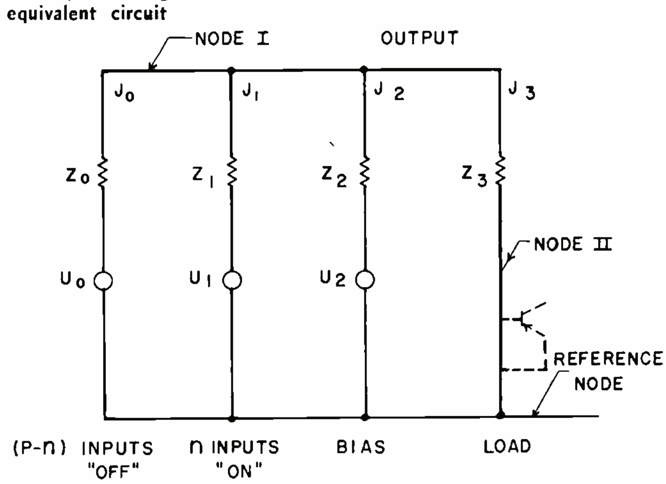


Fig. 7a (left): Logic of linear network, basic circuit; while Fig. 7b (below) illustrates an equivalent circuit



Page from an Engineer's Notebook

#50 Table of Exponentials, e^n and e^{-n}

By KLAUS H. JAENSCH
Sr. Electronic Eng.
Stromberg-Carlson Co.
Rochester, N. Y.

MOST common handbooks supply tables for ϵ^n and ϵ^{-n} versus n with values of n up to around 5 only. Occasionally, engineering problems run into higher exponents of one of these functions. A common example out of the electronic field is the question, how much charge is left on a capacitor after a certain discharging time.

The unusual arrangement of Table 1, believed to be novel, permits a wide range of values in a comparatively small space. One may easily extend the table for even higher values of n, if desired.

Based on the fact that the decimal cycle of both functions, 2.30259, closely approximates 2.3, the latter and its multiples are used as a repeating cycle of the table. For estimating the error in higher values of n in Table 1, Table 2 gives some exact figures as a cross-reference.

Example for use of Table 1.

Question: $\epsilon^{-6.3} = ?$

Procedure: $n = 6.3$ is found inside table. The respective horizontal line shows "0.183" in the left hand column, ϵ^{-n}. Heading of vertical column containing $n = 6.3$ calls for "divide ϵ^{-n} by: 100." Thus, $\epsilon^{-6.3} = 0.183 \div 100 = 0.00183$.

Table 1

ϵ^{-n}	Divide ϵ^{-n} by:				Multiply ϵ^{n} by:			ϵ^{n}
	1	10	10^2	10^3	10^4	10^5	10^6	
1.00	0	2.3	4.6	6.9	9.2	11.5	13.8	1.00
.905	0.1	2.4	4.7	7.0	9.3	11.6	13.9	1.10
.819	0.2	2.5	4.8	7.1	9.4	11.7	14.0	1.22
.741	0.3	2.6	4.9	7.2	9.5	11.8	14.1	1.35
.670	0.4	2.7	5.0	7.3	9.6	11.9	14.2	1.49
.607	0.5	2.8	5.1	7.4	9.7	12.0	14.3	1.65
.549	0.6	2.9	5.2	7.5	9.8	12.1	14.4	1.82
.497	0.7	3.0	5.3	7.6	9.9	12.2	14.5	2.01
.449	0.8	3.1	5.4	7.7	10.0	12.3	14.6	2.23
.407	0.9	3.2	5.5	7.8	10.1	12.4	14.7	2.46
.368	1.0	3.3	5.6	7.9	10.2	12.5	14.8	2.72
.333	1.1	3.4	5.7	8.0	10.3	12.6	14.9	3.00
.301	1.2	3.5	5.8	8.1	10.4	12.7	15.0	3.32
.273	1.3	3.6	5.9	8.2	10.5	12.8	15.1	3.67
.247	1.4	3.7	6.0	8.3	10.6	12.9	15.2	4.06
.223	1.5	3.8	6.1	8.4	10.7	13.0	15.3	4.48
.202	1.6	3.9	6.2	8.5	10.8	13.1	15.4	4.95
.183	1.7	4.0	6.3	8.6	10.9	13.2	15.5	5.47
.165	1.8	4.1	6.4	8.7	11.0	13.3	15.6	6.05
.150	1.9	4.2	6.5	8.8	11.1	13.4	15.7	6.69
.135	2.0	4.3	6.6	8.9	11.2	13.5	15.8	7.39
.122	2.1	4.4	6.7	9.0	11.3	13.6	15.9	8.17
.111	2.2	4.5	6.8	9.1	11.4	13.7	16.0	9.03
.100	2.3	4.6	6.9	9.2	11.5	13.8	16.1	10.0

Figures inside table are values of n

Table 2

Cross-Reference Table for even values of ϵ^n and ϵ^{-n}

n	ϵ^{-n}	ϵ^{n}
0	1	1
2.3026	10^{-1}	10
4.6052	10^{-2}	10^2
6.9078	10^{-3}	10^3
9.2104	10^{-4}	10^4
11.5129	10^{-5}	10^5
13.8155	10^{-6}	10^6
16.1181	10^{-7}	10^7

By DR. JOHN R. MADIGAN

V. P. in Charge of Eng'g.
Semiconductor Div.
Hoffman Electronics Corp.
Evanston, Ill.

Most electrical characteristics of semiconductors are temperature sensitive. Though usually undesirable, this quality does permit the easy measurement of important thermal properties. This article discusses the origin of the temperature variations.

Thermal Characteristics of

Part One of Two Parts

MOST of the electrical characteristics of semiconductor devices are temperature sensitive. While the variation of device characteristics with temperature is usually considered undesirable, it enables one to measure, in a very simple way, such device properties as thermal resistance and thermal time constants.

A typical current voltage characteristic for silicon junction diodes is shown in Fig. 1. It consists of three regions: a saturation region in which the current through the diode is very small and practically independent of voltage over a wide range of bias voltages; and forward and reverse breakdown regions in which the current through the device increases very rapidly with increasing positive or negative bias, respectively.

The characteristics of all three regions vary with temperature: the saturation current rises with temperature, while the voltage drop corresponding to a given forward current decreases with increasing temperature; and the reverse voltage corresponding to a given current in the reverse breakdown region may either increase or decrease with increasing temperature—depending upon whether the avalanche or zener breakdown mechanism predominates.

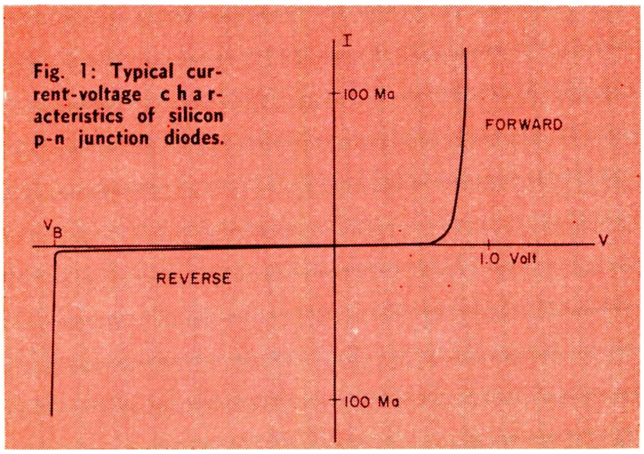


Fig. 1: Typical current-voltage characteristics of silicon p-n junction diodes.

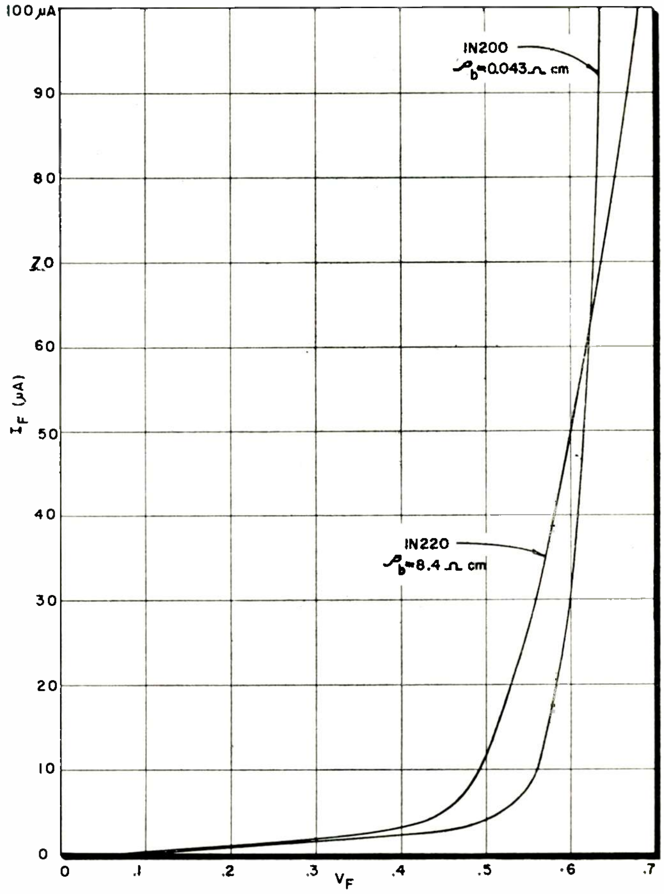
The above description is an oversimplification. It indicates that the temperature coefficient of forward or reverse breakdown voltage would be independent of the current at which it is measured, provided the chosen test current is well past the knee of the current voltage characteristic. However, the base layer resistance of the diode increases with increasing temperature over the resistivity and temperature ranges of interest. Therefore, the high temperature breakdown characteristics have a smaller slope than the low temperature characteristics. Thus, for diodes which initially have a negative temperature coefficient of either forward or reverse breakdown voltage, the temperature coefficient increases to zero, then changes sign and becomes positive. The characteristic curves corresponding to the different temperatures, first approach one another, then cross and begin to deviate again when the measuring current is gradually increased. For diodes which have a positive temperature coefficient of reverse breakdown voltage, the characteristics curves for different temperatures deviate more and more as the test current increases. This causes the temperature coefficient to increase steadily with the measuring current.

Forward Characteristic

Under conditions of forward bias, one must exceed a certain voltage before the current starts to increase rapidly. This voltage varies inversely with temperature and with the resistivity of the base region. This behavior suggests that it is a measure of the equilibrium barrier height.

By the term equilibrium barrier height[1] we mean the magnitude of the potential step between the n-

Fig. 2: Forward voltage drop as a function of forward current for diodes of different base layer resistivity.



Silicon Diodes

and p-sides of a p-n junction. Under forward bias conditions, the height of this barrier is reduced. Then one obtains an effective barrier height which, if effects of series resistance are neglected, is just equal to the equilibrium barrier height minus the applied bias.

Obviously, if one applies enough bias, the barrier will be completely wiped out and the forward voltage drop will be clamped at a value equal to the equilibrium barrier height. In an actual diode, the applied voltage is equal to the sum of the voltage drops across the junction and across the series resistance of the diode. The forward current is small until the barrier is overcome at the knee of the characteristic curve and the current and forward voltage drop are determined by the series resistance of the diode. The barrier height is approximately given by the intercept on the voltage axis when the straight line portion of the forward breakdown characteristic is extrapolated back to zero current.

In an ideal junction, the equilibrium barrier height equals the difference of the Fermi levels in the isolated n- and p- regions of the junction. If, in thought, one separates the n- and p- regions of a p-n junction, at very low temperatures the Fermi level is close to the bottom of the conduction band and to the top of the valence band in the n- and p-type crystals, respectively. When the two crystals are rejoined, electrons tend to flow from the electron rich n- to the p-side while holes flow from the hole rich p- to the n-side. This leaves a positive space charge layer on the n-side and a compensating negative space charge layer on the p-side of the junction.

This charge distribution produces a ramp type potential difference between the n- and p-regions. It lowers the energy levels on the n-side relative to those on the p-side until the Fermi levels on both sides of the junction coincide. The height of the potential step between the n- and p-regions is thus just equal to the difference in the positions the Fermi level would assume if the n- and p-material could be isolated.

Fermi Level

As the temperature is increased, the Fermi level approaches its intrinsic position. At sufficiently high temperatures the crystal becomes intrinsic, and there is no longer any distinction between the initially n- or p-type crystals. The rate of approach of the Fermi level to its intrinsic position is, among other things, a function of the impurity concentration and the energy gap of the semiconductor.[2] In particular, the rate of approach of the Fermi level to its intrinsic position with increasing temperature decreases with increasing impurity concentration. This suggests that in an alloy junction, where one region is much more heavily doped than the other, the equilibrium barrier height is essentially a measure of the position of the Fermi level in the high resistivity or base region of the diode.

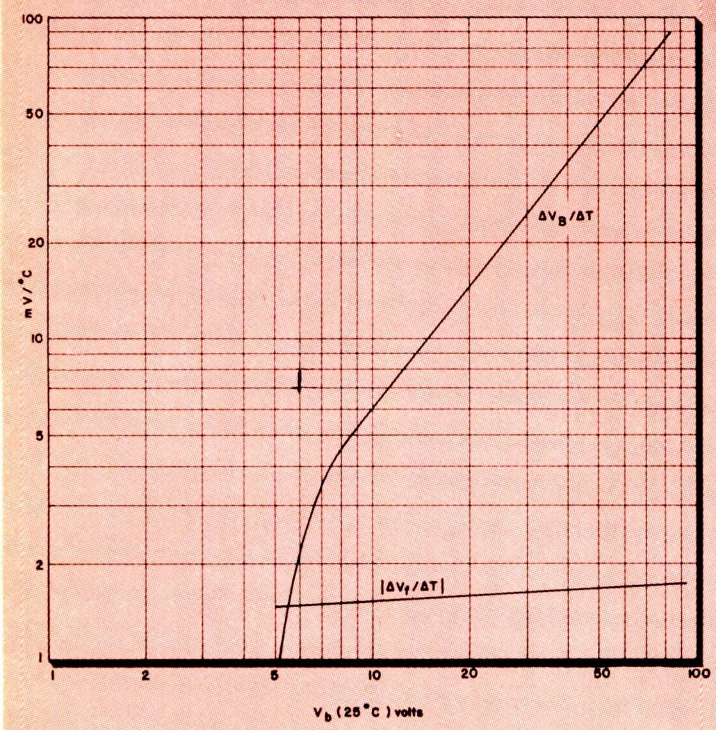
The relationship between the rectifying barrier and the Fermi levels discussed above accounts for most of the properties of the forward breakdown characteristic. The negative temperature coefficient of forward voltage drop is explained by the fact that the equilibrium height of the rectifying barrier, which is equal to the difference between the Fermi levels in the n- and p- material, decreases as the Fermi levels approach their intrinsic position with increasing temperature. For lower resistivity base regions the equilibrium barrier height is higher, Fig. 2, because the Fermi levels at any given temper-

Silicon Diodes *(Continued)*

ature would be closer to the band edges. For higher doping levels, i.e., lower resistivities, the Fermi level does not approach its intrinsic position as rapidly with increasing temperature because more intrinsicly created carriers are required to swamp the effects due to the impurity atoms. This means that the temperature coefficient of the forward breakdown characteristic will tend to increase slightly with increasing base layer resistivity. In Fig. 3 the change in forward and reverse breakdown characteristics per °C is shown as a function of the reverse breakdown voltage. Since higher breakdown voltages correspond to higher resistivities, the curves are equivalent to a plot as a function of base layer resistivity.

For the resistivity and temperature ranges usually employed for silicon diodes, the temperature coefficient of resistivity is positive.[3] If the sample is not too heavily doped, i.e., is not degenerate, the resistivity will at first decrease with increasing temperature as the number of ionized impurity atoms increases. However, the mobility decreases with increasing temperature due to the increased scattering of the charge carriers by lattice vibrations. Thus in non-degenerate crystals there are two conflicting contributions to the resistivity. At sufficiently low temperatures, the rate of increase of carrier concentration with temperature, due to the ionization of the impurities, exceeds the rate of decrease of the mobility, due to increased lattice scattering, and the resistivity decreases with increasing temperature. When the temperature is high enough to have ionized all the impurity atoms, the mobility effect takes over

Fig. 3: Change in breakdown characteristics per °C, measured at 10 ma., as a function of the reverse breakdown voltage.



and the resistivity rises with increasing temperature. Eventually the temperature becomes high enough to produce appreciable numbers of intrinsic carriers and the resistivity again decreases with temperature. In degenerate samples, the impurities are all ionized at very low temperatures and the resistivity increases with increasing temperature due to the mobility effect until intrinsic conduction takes over.

Higher Temperatures

Higher temperature characteristic curves show higher series resistance because of the positive temperature coefficient of resistance. The resulting higher *IR* drop forces the characteristic curves to cross one another at a current which depends on the resistivity and geometrical factors.

Fig. 4 shows some typical forward characteristics for Hoffman IN200 series alloy diodes. Higher type numbers correspond to higher breakdown voltages and consequently higher base layer resistivity. The positive temperature coefficient increases with increasing resistivity so that the characteristic curves for diodes with higher reverse breakdown voltages cross over at lower forward currents.

The approximate dependence of the breakdown voltage on base layer resistivity for some silicon alloy diodes is shown in Fig. 5. The dashed curve corresponds to diodes formed by alloying aluminum into n-type silicon while the full curve corresponds to diodes formed by alloying antimony doped gold into p-type silicon. These curves enable one to plot the cross over current as a function of the base layer resistivity. The cross over current should be directly proportional to the base layer resistivity so that the data will plot as a straight line. This statement is well borne out by the curves of Fig. 6 which plot the cross over current as a function of base layer resistivity for both the Hoffman IN200 series of silicon alloy diodes and IN450 series (456-459) of glass encapsulated diodes. The difference in slope is due to the lower spreading resistance associated with the uniaxial construction of the IN450 series as opposed to the single ended construction of IN200 series. One may employ the cross over characteristic to obtain a reference voltage, which is relatively insensitive to temperature change over a wide range of temperatures, by biasing a diode at its forward cross over current.

Saturation Region

As one applies reverse bias voltage to a p-n junction, the height of the rectifying barrier increases. This reduces the forward current while the reverse current across the junction remains essentially the same. The dynamic equilibrium which existed for the case of zero bias is thus disturbed, and there is a net reverse current across the junction.

In 1949, Shockley proposed a model of the p-n junction which leads to a simple expression for the diode characteristic.[4] If one neglects the effect of series resistance, the model leads to an exponential dependence of forward current on bias voltage when the bias is large enough; and, to a reverse saturation current for large reverse bias voltages.

The saturation current consists of the flow across the junction of electrons from the p- to the n-side and of holes from n- to the p-side. The electron and hole components of the saturation current at the junction are directly proportional to the resistivities of the p- and n- regions in which they originate, respectively. Thus, for junctions produced by either alloying or diffusion techniques, the base material will normally be of considerably higher resistivity than the alloyed or diffused region. Most of the reverse current at the junction will consist of minority carriers flowing from the base into the alloyed or diffused material. This concept will be useful later in discussing the reason for the difference in breakdown voltage between p- and n- material of the same resistivity.

The temperature dependence of the reverse current is complicated by the many factors that even in the simple theory contribute to it. The general result is that the reverse current increases strongly with temperature and the temperature dependence of the reverse current has been made the basis for measurements of junction temperature.[5]

However, the reverse current is so dependent upon other factors, such as surface leakage, that the temperature dependence of the forward, or reverse, breakdown characteristics is a more reliable measure of the junction temperature. In particular, measurements on actual diodes result in more reverse current than given by the simple theory. Part of this current may be due to surface leakage. That is, the effective barrier resistance is shunted by a surface leakage resistance which may be comparable to, or less than, the barrier resistance for reverse bias conditions.

After the surface leakage has been greatly reduced, or eliminated, by proper treatment of the surface, excess current is still observed in silicon junctions at room temperature. This extra, over the simple theory, current has been attributed to charge generation in the barrier region.[6, 7, 8, 9] The reverse space charge generation current is proportional to the volume in which generation occurs and is thus proportional to the barrier width. Since the barrier width increases with reverse bias, there is no true reverse saturation current for silicon diodes at room temperature where the space charge generation dominates the reverse current.

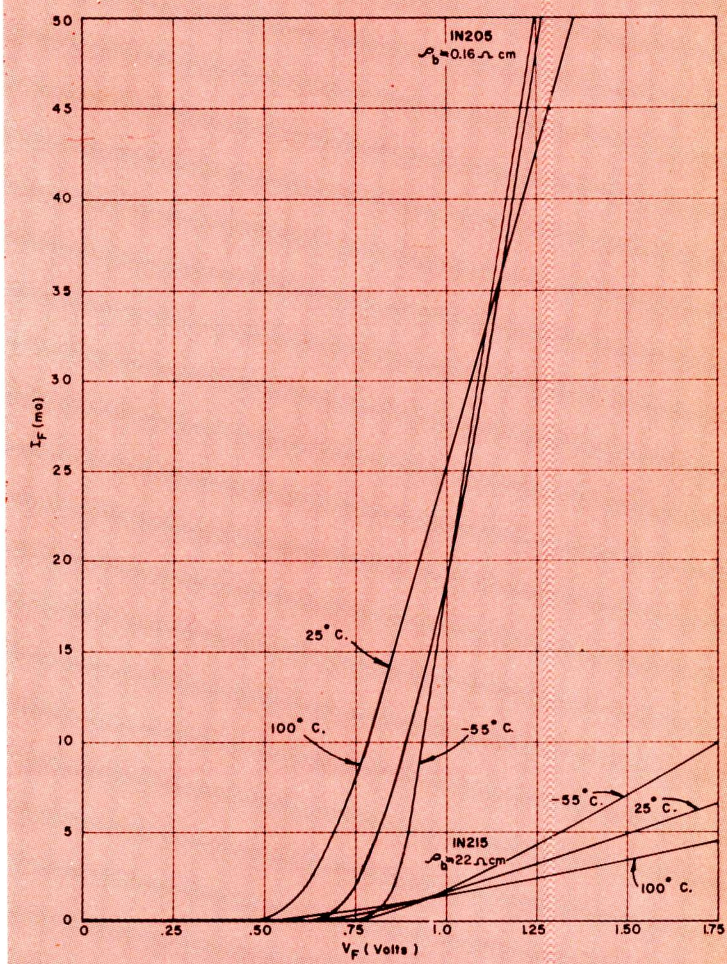


Fig. 4: Forward voltage drop as a function of forward current for diodes of varying base layer resistivity with temperature as a parameter.

Reverse Current

The space charge generated current also explains the disparity in reverse current between otherwise identical alloyed and diffused junction diodes. Diffused junction diodes of the same area and made from the same base material as alloy units typically have a higher reverse current. The diffusion process tends to produce a graded junction while the alloy process tends to produce an abrupt junction. The wider space charge layer associated with the graded junction then results in more space charge generated reverse current.

On the basis of any of the currently proposed theories of the diode characteristic one might reasonably expect to find a correlation between the low temperature and high temperature reverse currents. Thus, those units which show small reverse currents at room temperature should still be low at elevated temperatures; those that have large should be correspondingly high.

Unfortunately, slight variations in surface properties from unit to unit make it difficult to test this hypothesis. However, it usually holds for carefully prepared samples made from the best transistor grade silicon doped with only a majority carrier impurity to the desired resistivity. Deliberately or accidentally compensated material on the other hand shows an abnormally high rate of increase in reverse current with temperature.

A tentative explanation of these results is that compensated material effectively "stores" the minority carriers which produce the reverse current and releases them with increasing temperature more rapidly than intrinsic carriers are created. For exam-

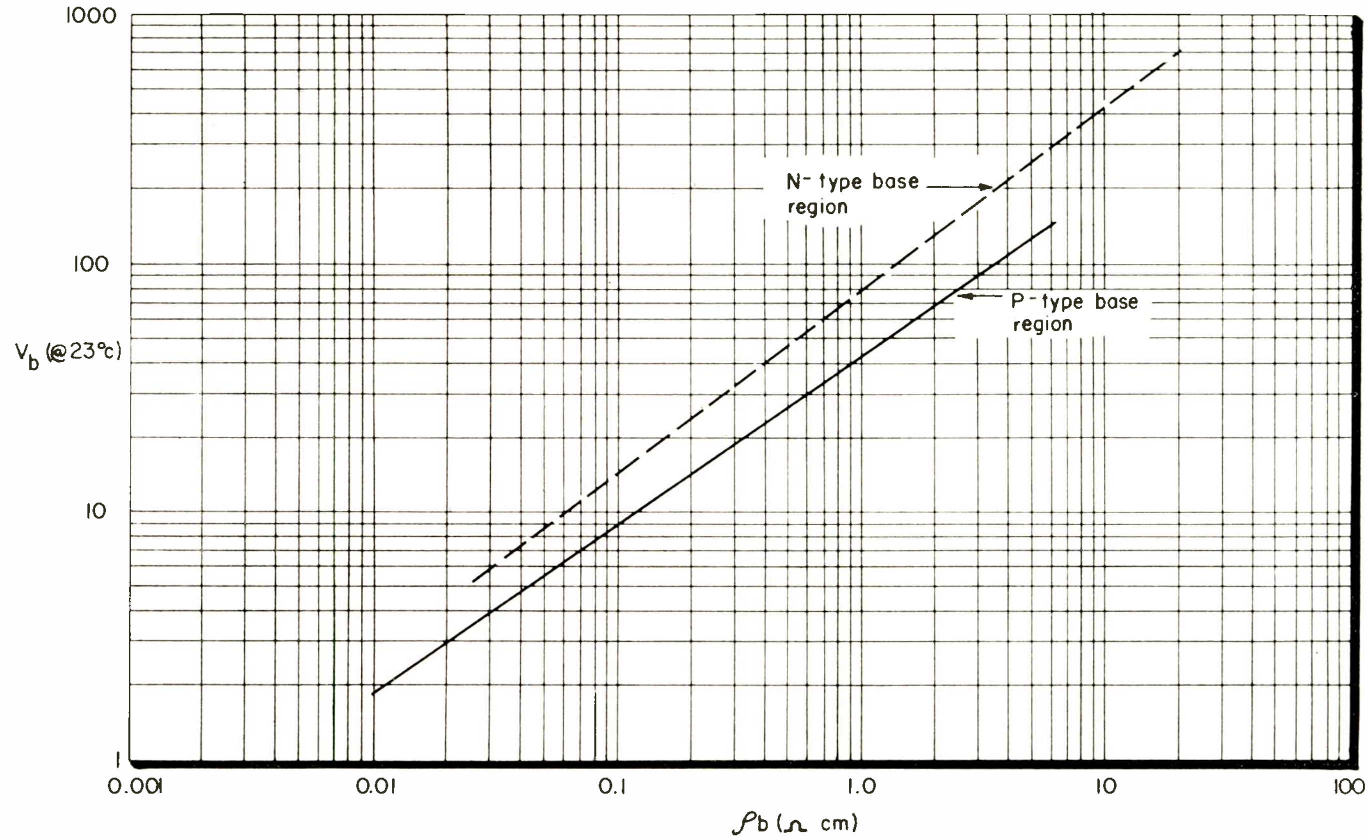


Fig. 5: Reverse breakdown voltage of alloy junctions as a function of base layer resistivity for n- and p-type base regions.

Silicon Diodes *(Continued)*

ple, in an aluminum alloy junction, the principal contribution to the reverse current at the junction is from holes in the n-type base material. At low temperatures, the number of holes available to carry the reverse current is the same for both compensated and pure material since the acceptor atoms have captured their electrons from the additional donors that must be added to keep the resistivity constant. We are neglecting as a second order effect the reduction in mobility due to increased scattering in the compensated material.

The extra holes that would have been created by the presence of the acceptors are effectively stored in the valence band until increasing temperature frees the donor atom electrons. The acceptors then capture electrons from the valence band producing more holes than would normally arise from intrinsic pair production.

Reverse Breakdown Region

As the reverse bias voltage is increased, the reverse current remains small until the voltage reaches a value near V_B, the breakdown voltage, Fig. 1. At V_B, the current increases extremely rapidly and the device is said to go into the reverse breakdown regions. This breakdown is not destructive and one can cycle into and out of the breakdown condition indefinitely as long as the unit is kept within the thermal limitations.

The breakdown voltage is a function of the resistivity of the base material and the impurity gradient at the junction.[10] For alloy diodes the transition from p- to n- material is abrupt so that the only variable in determining the breakdown voltage is the resistivity of the base region. In the case of diffused junctions the rate of the transition from p- to n-material can be controlled by varying the diffusion program. For example, one might fix the diffusion temperature and vary the diffusion time. Longer times would correspond to less steeply graded junctions and higher breakdown voltages.

The breakdown voltage is plotted as a function of base layer resistivity for some diffused junction diodes with diffusion time as a parameter in Fig. 7. The data shown in Figs. 5 and 7 indicate that either alloy or diffused diodes made with n-type base material breakdown at higher voltages than those made from the same resistivity p-type material. This may be understood by recalling that the reverse current across the barrier consists principally of minority carriers from the base regions. Thus for an n-type sample the reverse current before breakdown is composed principally of holes and of electrons for a p-type sample. As these carriers enter the barrier layer they are accelerated by the high fields associated with this region and, in the case of avalanche breakdown, acquire high enough velocities to cause ionization by collision.

The newly created carriers produce more in turn and an avalanche builds up which results in the observed reverse breakdown characteristic. The mobility or drift velocity per unit field is greater for electrons than for holes[11, 12] so that the electrons will not require as high a field to reach a given velocity.

Since the field is proportional to the voltage across the space charge layer, this means that for those diodes in which the reverse current is carried principally by the electrons, viz., diodes with p-type base material, the breakdown voltage will be lower than for those in which the reverse current consists mostly of holes, viz., diodes of n-type base material. The ratio of breakdown voltage for otherwise identical n- and p-type base diodes does not stay constant but decreases with decreasing resistivity.

This is consistent with the behavior of the mobility which decreases with resistivity due to increased impurity scattering. In fairly pure samples, the mobility is determined by lattice scattering. At room temperature, the ratio of electron to hole mobility is approximately three. As the impurity concentration increases, the mobility falls and the ratio decreases and approaches unity as impurity scattering becomes dominant. For the range of voltages depicted in Fig. 5 the ratio changes from about 1.5 on low voltage units to 2.4 for higher voltage diodes. These results are in qualitative agreement with the mechanism postulated above.

Breakdown Mechanisms

As indicated in Fig. 3, the reverse breakdown characteristic varies with temperature. Above about 5.4 volts the breakdown voltage increases with temperature, i.e., has a positive temperature coefficient, while below this voltage it decreases with increasing temperature. This behavior is explained by the fact that there are two competing breakdown mechanisms operative.

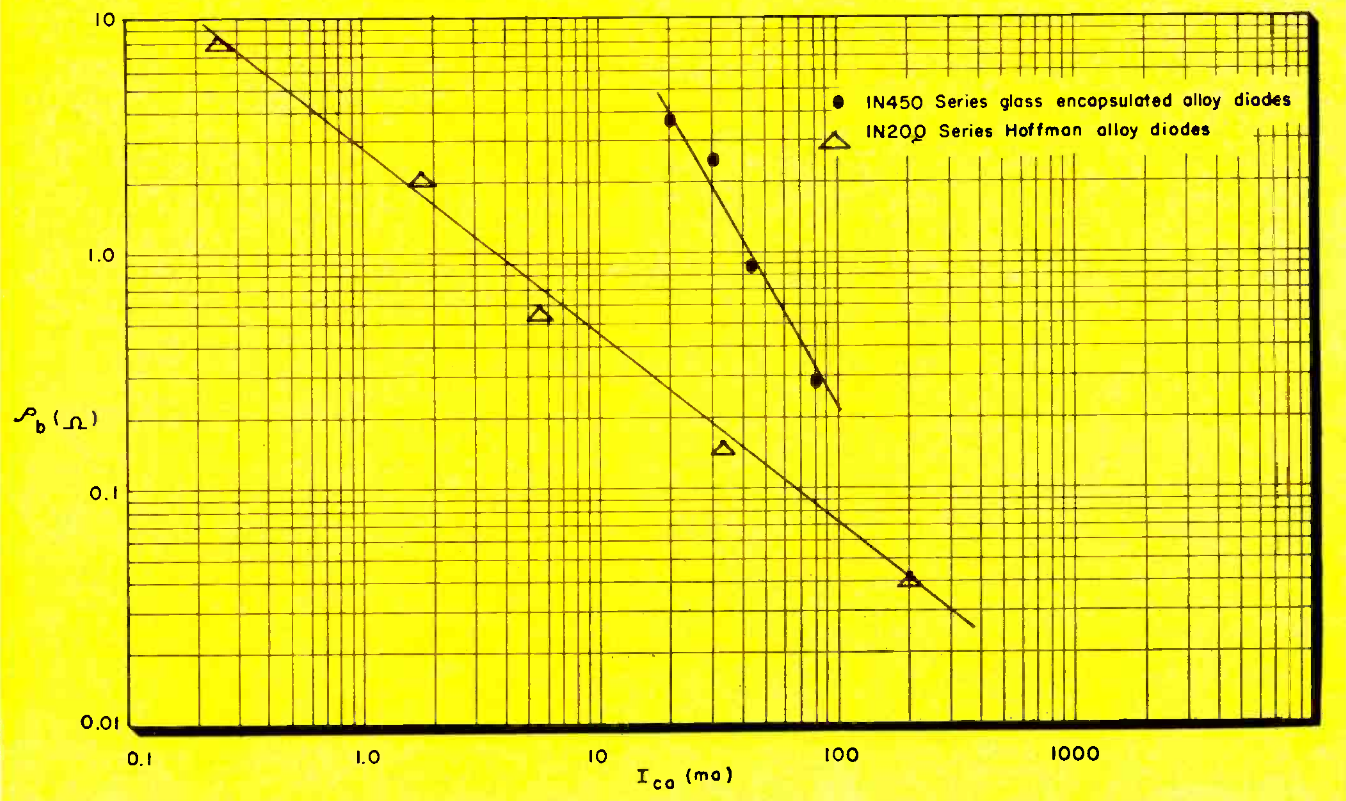
The zener mechanism of breakdown in insulators is due to the internal field emission of electrons from the valence band to the conduction band in the presence of strong electric fields. For higher temperatures the forbidden energy band is reduced in width and thus a lower electric field is needed to cause the zener breakdown. Zener diodes, therefore, have a negative temperature coefficient of breakdown voltage and this phenomena occurs in diffused diodes below a breakdown voltage of about 5.4 volts.

The positive temperature coefficient of diodes with breakdown voltages greater than about 5.4 volts is accounted for by an explanation based on an avalanche mechanism. This is the same phenomena that takes place in a gaseous discharge.

During a mean free path a charge carrier in the high field space charge region will pick up enough energy to cause ionization on collision leading to mobile charge multiplication. At higher temperatures, the mobility of the charge carriers is reduced and higher electric fields are necessary to cause the charge carriers to pick up enough energy in a mean free path to produce the multiplication or avalanche phenomena.

The temperature coefficient of reverse breakdown voltage is usually defined as the percentage change in breakdown voltage per °C. This parameter is unfortunately a function of the current at which it is measured and this fact may account for the discrepancies between temperature coefficients listed by various manufacturers. In Fig. 8 we present a composite plot of temperature coefficient data of various manufacturers. The temperature coefficient is zero

Fig. 6: Crossover current as a function of base layer resistivity for some alloy junction diodes.



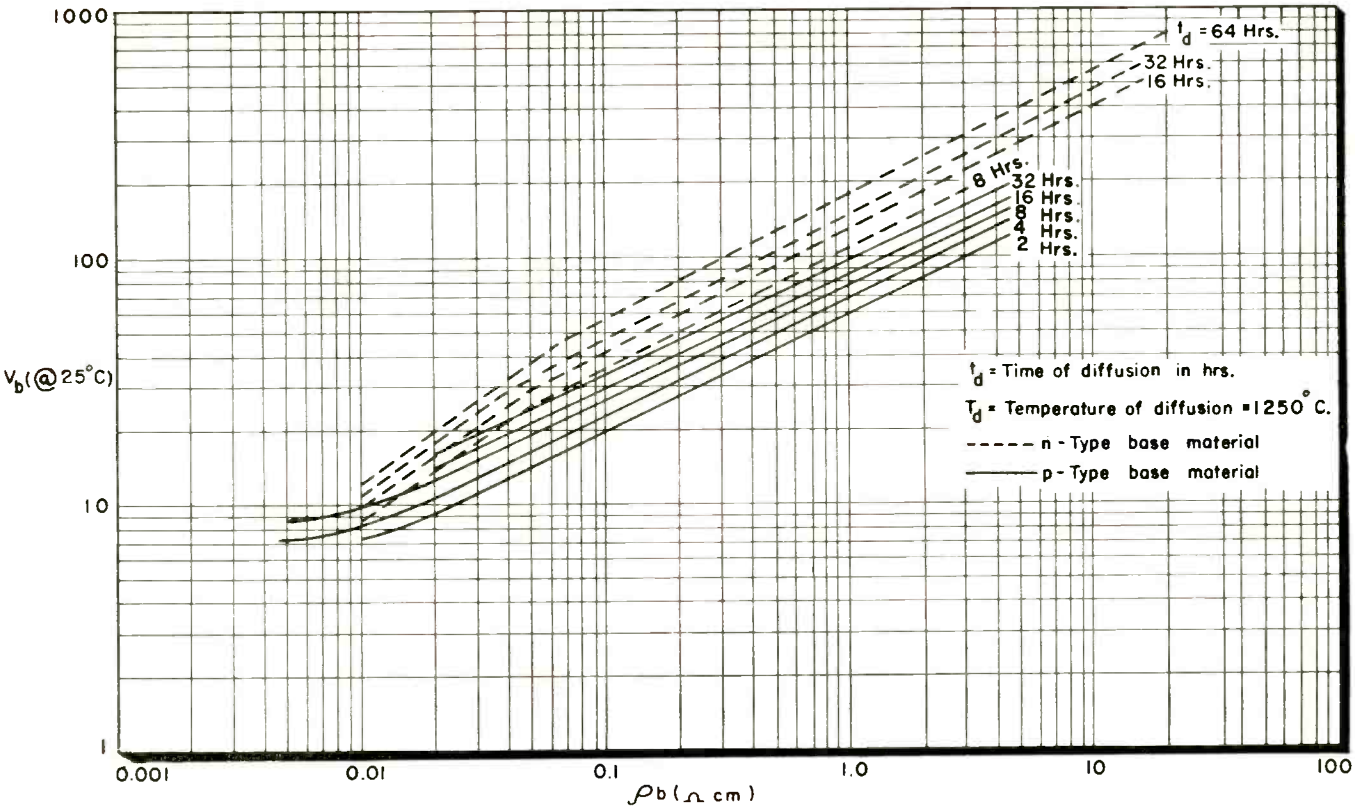


Fig. 7: Breakdown junction of diffused junction diodes measured at a reverse current of 10 ma., as a function of base layer resistivity for n- and p-type base regions with diffusion time as a parameter.

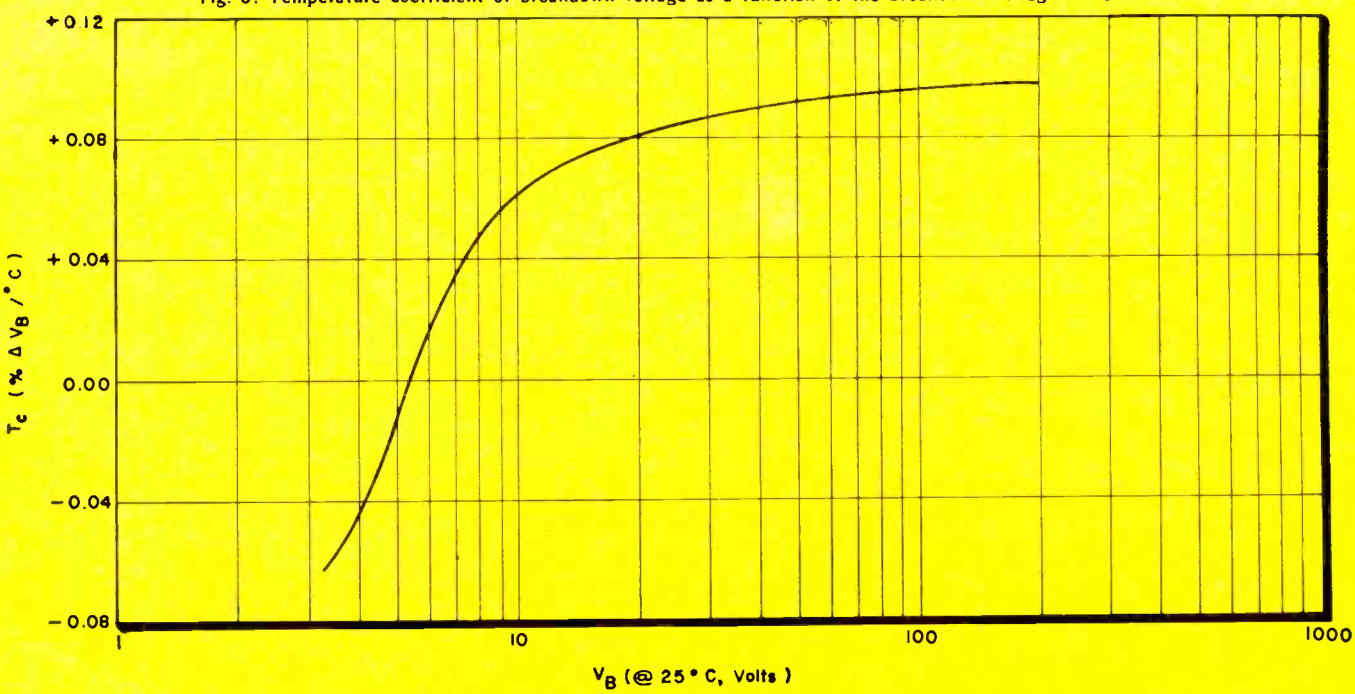
Silicon Diodes *(Continued)*

at a breakdown voltage of 5.4 volts and increases in magnitude as one proceeds to higher and lower breakdown voltages.

The impedance in the reverse breakdown region decreases as the reverse current is increased and one leaves the region of the "zener" knee. At large reverse currents, it stabilizes at a value that is somewhat higher than the forward impedance, see Fig. 9. The forward impedance is a measure of the series resistance of the diode and increases with base layer resistivity. The reverse impedance also increases in diodes of higher base layer resistivity.

The higher reverse impedance is attributed to the fact that the forward and reverse breakdown mechanisms are not the same. In the reverse direction the junction does not break down uniformly but rather in microplasmas.[13] The net effect of conducting the

Fig. 8: Temperature coefficient of breakdown voltage as a function of the breakdown voltage at 25° C.



reverse breakdown current by means of a large number of microplasmas in parallel is that the saturation value of the reverse impedance is approximately the spreading resistance of one microplasma divided by the number of microplasmas contributing to the reverse current.

The spreading resistance is given by the base layer resistivity divided by the diameter of the microplasma. Just as in the case of the forward characteristic, the positive temperature coefficient of resistance will result in a temperature coefficient of breakdown voltage that varies with current. For an avalanche diode, the characteristic curves for different temperatures would tend to spread more as current increased due to the positive temperature coefficient of resistance. Those for a true zener diode would approach one another, cross and then spread again. Initially, positive temperature coefficients would, therefore, become greater with increasing current; negative ones would decrease in magnitude to zero, then change sign and increase as the reverse breakdown current increases. Operation near the cross over current, therefore, results in a diode whose breakdown voltage is almost independent of temperature—a so-called reference diode.

Recombination Radiation

Under suitable conditions[14, 15, 16] one can observe recombination radiation in the vicinity of a p-n junction undergoing reverse breakdown. The recombination radiation may be explained as follows: when an electron and hole recombine, their excess energy is given off in the form of phonons, which produce heating of the crystal lattice, and/or as photons, which, when of suitable wavelength, appear as visible points of light. During reverse breakdown, there is a high generation and recombination rate in the space charge layer. If one observes a large area, shallow junction, such as a solar cell, under low power magnification, regions of high recombination rate appear as luminous points or lines, which grow in number and intensity as the reverse current is increased.

The increased brightness of the individual spots may be due to a slight increase in size with increasing current. This behavior would partially account for the dependence of the reverse breakdown impedance on current; it is also partially due to an increase in the number of active microplasmas with necessary reversed current.

The spreading resistance of an individual microplasma will decrease as its diameter increases until it reaches some maximum at which the value of the reverse breakdown impedance saturates. It must be emphasized that this explanation of the variation of reverse breakdown impedance with current should only be regarded as a plausibility argument.

As either the forward or reverse current is increased, self heating of the diode, due to its finite thermal resistance, may result in a negative resistance region in the forward or reverse breakdown characteristic. The thermal resistance of a diode is a measure of the rise of junction above ambient temperature per watt of power dissipated in the device. The current required to produce appreciable self

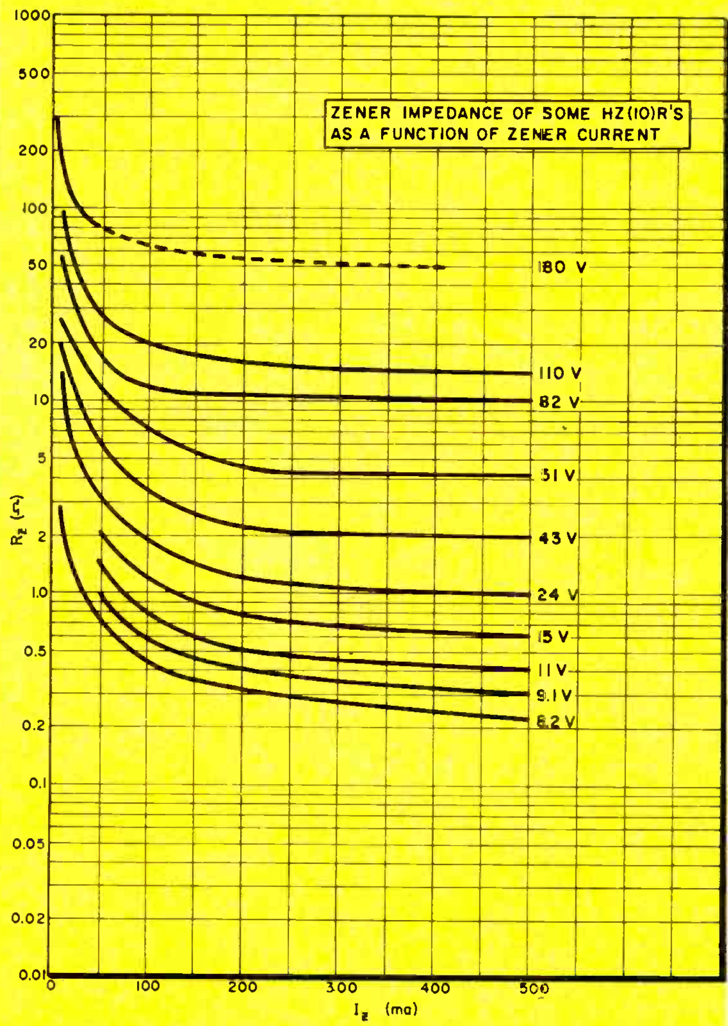


Fig. 9: Reverse breakdown impedance as a function of reverse current.

heating will be less in the reverse than in the forward breakdown region because of the higher voltages involved. When the temperature becomes high enough for intrinsic conduction, the negative resistance portion of the breakdown characteristic appears. The temperature at which intrinsic conduction occurs decreases with increasing resistivity and it is quite easy to obtain this thermal breakback in the characteristic of reverse biased junctions. It is an unstable condition which may lead to thermal run away and should be avoided.

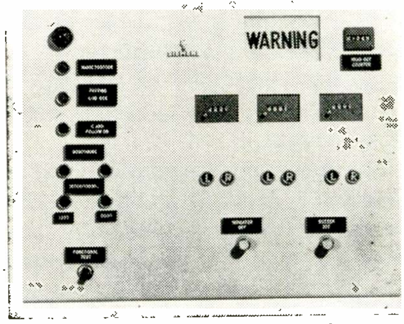
(*Continued next month*)

References

1. B. R. Gossick, *J. Appl. Phys.* 26, 1356 (1955).
2. R. A. Hutner, E. S. Rittner, and F. K. DuPre, Phillips Research Reports, 5, 188 (1950).
3. G. L. Pearson, and J. Bardeen, *Phys. Rev.* 75, 865 (1949).
4. W. Shockley, *Bell Sys. Tech. J.* 28, 435 (1949).
5. K. E. Loofloourrow and J. Ollendorf, *Transistors I*, 353 (1956), edited by RCA Laboratories, Princeton, N. J.
6. C. T. Sah, R. N. Noyce, and W. Shockley, *Proc. IRE* 45, 1228 (1957).
7. H. Kleinknecht and K. Seiler, *Zeits. f. Physik.* 139, 599 (1957).
8. E. M. Pell and G. M. Roe, *J. Appl. Phys.* 26, 658 (1955).
9. H. S. Veloric and M. B Prince, *Bell Sys Tech. J.* 36, 975 (1957).
10. H. S. Veloric, M. B. Prince and M. J. Eder, *J. Appl. Phys.* 27, 895 (1956).
11. M. B. Prince, *Phys. Rev.* 92, 681 (1953).
12. M. B. Prince, *Phys. Rev.* 93, 1204 (1954).
13. B. Senitzky and J. L. Moll, *Phys. Rev.* 110, 612 (1958).
14. A. G. Chynoweth and K. G. McKay, *Phys. Rev.* 102, 369 (1956).
15. D. J. Rose, *Phys. Rev.* 105, 413 (1957).
16. A. G. Chynoweth and K. G. McKay, *Phys. Rev.* 106, 418 (1957).

What's New . . .

I-R "Hot Box" Detector



Fully automatic readout feature makes possible positive detection without the need for operator judgment. Audible alarm eliminates need for constant surveillance.

AN advanced infrared sensing device that automatically detects dangerously over heated railroad car journal boxes made its first U. S. appearance at the annual meeting of the Signal Section Convention of the Association of American Railroads in Washington.

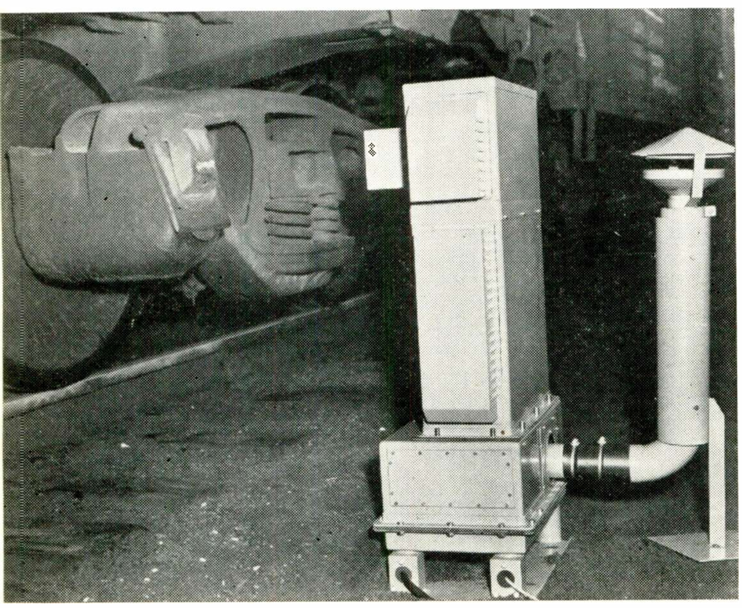
Developed by Siemens-Halske of Brunswick, West Germany, it will be manufactured and distributed in the United States by Link Aviation, Inc., a General Precision Co., Binghamton, N. Y., under a licensing agreement. These detectors have been in use in Europe for the past three years.

It is interesting to note that last year, American railroads experienced 156,720 "hot boxes". This does not sound like much, what with 8 journal boxes on each car. But these few incidents caused 556 derailments or wrecks—resulting in over $8½-million in damage to rolling stock and claims paid to shippers. The figure does not include equipment and road repairs.

The device provides foolproof detection of a "hot box" without the need for human interpretation. This is accomplished by unique temperature sensing and comparison mechanisms in the equipment which accurately distinguishes a "hot box" from journal boxes operating at acceptable temperatures.

The detector has several advantages over similar types of infrared devices currently in use, according to D. D. Mason, Link's president. The temperature measuring concept upon which this equipment design is based enables it to operate fully automatically, removing the need for operator judgement or attention. Climatic temperature fluctuations, and other variables influencing the ambient of normally functioning journal boxes, are automatically compensated for without requiring reduction of detector sensitivity. The equipment requires fewer components and is smaller in size than existing U. S. "hot box" detection systems.

Mr. G. Rehschuh, director of research of Siemens' Railroad Signalling Department, and Dr. Woltersdorf, who is responsible for development of the detector, traveled to this country to assist in its introduction here.



Foolproof detection is provided through unique temperature sensing and comparison mechanisms; thermocouple is used in place of a bolometer.

The "hot box" detector represents an extension of Link's activities in the railroad industry. Earlier this year Link introduced its "Tracer Identification and Control System" which automatically identifies railroad rolling stock.

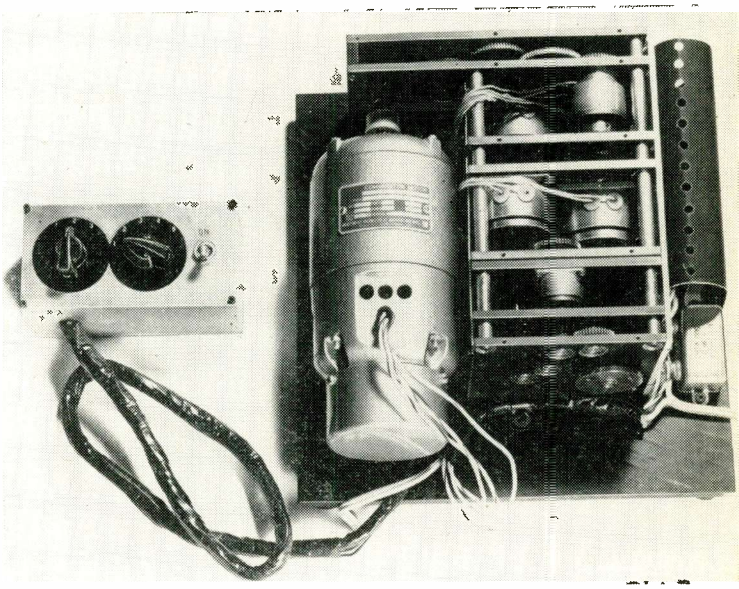
Link's activities in the railroad industry are still another step forward in the company's diversification and expansion program.

The fully automatic system requires 650 watts of 110 v. or 220 v., 60 cycle, single phase. No charts are needed, nor is constant monitoring—visible lights and audible sounds give warning of danger, Reliable "hot box" indications are provided for train speeds up to 60 mph.

Equipment is automatically checked upon each train passage by means of built-in self checking feature. It's operation can also be verified at any other time by actuating this system.

Each detector site will have a sensor on both sides of the track. Each sensor has means to sense present outside ambient temperature and, through unique comparison mechanism, determine whether the journal box presently passing the infrared viewer is heated beyond an acceptable operating temperature. These high temperature indications are converted to an electrical signal, which can be transmitted over existing signal or communications channels to the remotely located readout equipment. The readout equipment will give a hot box alarm both audibly and visually. It will display the axle location and side of train of the detected "hot box".

A Rugged Multi-Speed Transmission



The multi-speed transmission will operate at 15 speeds. Speeds may be changed while unit is operating without harmful effects. Speed changes are made with switches shown on the left.

ENGINEERS of the Dynamic Gear Company, Amityville, N. Y., have completed the design and development of a miniature 15-speed transmission. The unit features accurately controlled speeds, very high torque for its size, and ruggedness.

The fifteen speeds range from 3.3 RPM to 7812 RPM. Speeds are changed by merely dialing the desired speed. No manual shifting of gears is required. Speed changes can be made while the unit is running, with no harmful effects.

All of the gears and shafts in this transmission are constructed of either #303 stainless steel or 24 ST aluminum. The magnetic clutches, as well as the gears, are designed for years of service.

Case dimensions, excluding power source and control panel, measure 4¼ in. in width, 7¼ in. in length and is only 3⅝ in. high. Torque developed at the various speeds range from 50 oz.-in. to well over 100 oz.-in.

The input motor is reversible and will deliver the above speeds and respective torque in either direction. The motor speed is self-governed and accurately maintained at 8500 RPM. Units operate on 115 v, 60 or 400 cycle current.

Typical applications of the multi-speed transmission are for recording instruments such as oscillographs and other recording devices requiring constant and precise speeds. It can also be used as a laboratory device for testing servo packages along with many other uses.

Dynamic Gear will design special models to suit individual requirements. The transmissions can be supplied in many speeds, with up to 16 different speeds on one unit.

For Printed Circuits . . .

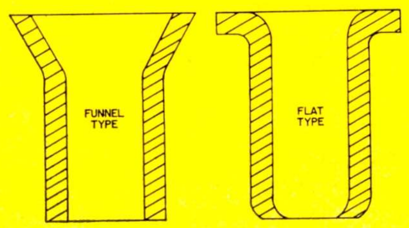
Eyelet Setting

BOTH funnel and flat flange eyelets, Fig. 1, can be set in automatic power machines. The eyelets are fed from a hopper down a set of rails to a pick-off position. The board is placed over the pilot of the anvil and the eyelet is automatically picked off and set when the operator steps on the treadle.

When printed circuit eyeletting was begun, standard all-purpose eyeletting machines were used; however, it soon became apparent that special attachments and techniques were vital to attain the trouble-free production required. The principal problems encountered were frequent tool breakage due to the small diameter of the eyelets; contamination of the eyelets which reduced their solderability; loose mechanical joints which failed in environmental tests; and, collapsed eyelets which did not extend completely through the board. The last problem was particularly common where funnel flange eyelets were used. It is worth while to describe the features in the Edward Segal Company's Model NRLT which were developed to deal with these problems. The firm is located at 132 Lafayette St., New York 13, N. Y.

Tool breakage was overcome by making possible extremely accurate alignment between the top and bottom tools and by the limited travel spindle. In a machine equipped with this feature, travel of the spindle is controlled during the downward execursion of the ram. The spindle is stopped approximately 1/64 in. above the pilot of the anvil. Tool breakage due to deflection is thus completely eliminated.

These two types are the eyelets most commonly used in printed circuit operations.



Where eyelets are gold or tin plated for solderability the raceway is chromed to seal off the surfaces which come in contact with the eyelets before pickoff.

Since all printed board material will vary approximately ±10% it was necessary to spring load the anvil to compensate for this variation.

A similar tool block with a pressure pad-TH3, Fig. 2, was developed for funnel eyelet setting. The pressure pad raises the board approximately 1/16 in. above the

(*Continued on page* 168)

In the 18 months since EI reported to industry on the introduction of voltage variable capacitors, significant improvements have been made that greatly extend the range of their electronic applications. Recent advances make them useful as: frequency multipliers, ultra-high frequency parametric amplifiers, and electronic tuning elements.

Voltage-Variable Capacitors—State of the Art

By MORGAN E. McMAHON and LEE S. CHASE
Pacific Semiconductors, Inc.
10451 West Jefferson Blvd.
Culver City, Calif.

THE voltage sensitivity of semiconductors' junction capacitance has been known for some time. Voltage variable semiconductor capacitors are used in large numbers of applications, such as tuning, frequency modulation, automatic frequency control, amplification, and variable filtering. The significant advantages over other variable reactance devices include subminiature size, fast response, electrical rather than mechanical control, ruggedness, and useful operation over a wide frequency range. This article describes the present state of the variable capacitor diode art as advanced beyond that previously described.[1]

Characteristics

Fig. 1 shows the equivalent circuit which describes the voltage variable capacitor. Fortunately, for most frequencies of normal operation, it can be simplified to an equivalent series resistance and the capacitance which is a function of applied voltage. Fig. 2 shows the capacitance versus voltage relationships for two types of junctions; the abrupt junction which shows an inverse square root relationship, and a diffused junction which shows an inverse cube root relationship. It is to be noted that these devices have a built-in internal contact potential which causes a deviation from the true power law at lower voltage levels. In some applications, such as parametric amplification, the cube root versus square root relationships do not constitute a particular practical difference. In other applications, such as harmonic generation or electronic tuning, the wide capacitance range available from the abrupt junction device offers a distinct advantage.

Significant characteristics in voltage variable capacitors are nominal capacitance, capacitance range,

(1) "Voltage Variable Capacitor," G. F. Straube (2 parts), *Electronic Industries*, pp. 69-73, May, 1958; pp. 77-80, July, 1958.

TABLE 1

PROPERTIES OF GENERAL-PURPOSE VOLTAGE VARIABLE CAPACITORS

Property	Previously Available	Presently Attainable Advance Types
C (Nominal)	7 – 100 $\mu\mu$f at −4 Vdc	1 – 1500 $\mu\mu$f at −4 Vdc
C Range	5.0:1	5.0 to 10.0:1
Voltage Sensitivity	$(V + V_o)^{-1/2}$	$(V + V_o)^{-1/2}$, $(V + V_o)^{-1/3}$
R_s	2 – 7 ohms at 47 $\mu\mu$f	.34 – 1.4 ohms at 47 $\mu\mu$f
$Q = \frac{1}{2\pi f R_s C}$	9 – 30 at −4 Vdc and 50 mc	50 – 200 at −4 Vdc and 50 mc
$f_c = \frac{1}{2\pi R_s C}$	500 to 1500 mc	2,500 to 10,000 mc
1	10 mμh	2 – 10 mμh

and "Q" or figure of merit. Since the Q of these devices varies in an inverse manner with frequency, there results a need for the specification of a test frequency. This problem is often resolved by the use of a "cutoff frequency" figure, stated as the frequency at which Q would go to unity assuming a 1/f relationship:

$$f_c = \frac{1}{2\pi R_s C}$$

State of the Art

Voltage variable capacitors have been used for two prime purposes, both as voltage controlled capacitors, such as for electronic tuning, and in parametric amplifiers. This article treats the state of the devices, excluding microwave parametric amplifier units. None of the early devices have been entirely adequate for use beyond those of frequency modulation in automatic frequency control. Recent advances have led to an advancement in the capability of these devices as frequency multipliers, ultra-high frequency parametric amplifiers, and as electronic tuning elements. Capacitance ranges on the order of six to ten to one, Q's of fifty to two hundred at 4 volts and 50 MC, and control of capacitance value and tracking have opened up these new areas of device utilization. Table I shows the characteristics available in the general purpose voltage variable capacitors. Previously available units have the properties described, salient features being available capacitances of the 7-100 micromicrofarad nominals at 4 volts, capacitance ranges of about 5:1, and Q factors at 4 volts ranging from 9-30. It is to be noted that the Q factor must be stated at a given frequency and a given voltage since the Q will increase as applied bias voltage increases and as applied signal frequency decreases. The devices now available, and those which will be available in the near future, are listed in the 3rd column of Table I. It should be noted that wider capacitance ranges are being made available; that the available nominal capacitances are broader; and that the Q factors are much higher than those previously available. Effort will be made to reduce package inductanes in order to raise the series resonant frequencies of the devices. Table II shows the properties of commercially available sub-microwave voltage variable capacitors.

The PSI "High-Q" units are abrupt junction devices developed under a Signal Corps contract.[2] It is to be noted that these units combine high-Q factors with wide capacitance ranges.

Some Problems

Inspection of the equivalent circuit and characteristics of the devices readily shows the existance of complex instrumentation problems. The capacitance varies as a function of applied voltage. The Q factor varies as a function of frequency. The capacitance at low voltage is somewhat a function of temperature. A standard method of testing and describing these devices must be evolved. Industry-wide usage of these devices has given rise to a method of specification

(2) "Variable Capacitor Diodes," Contract No. DA-36-039 SC-75044, *U. S. Army Signal Supply Agency*, Technical Surveillance under U. S. Army Signal Research and Development Laboratories.

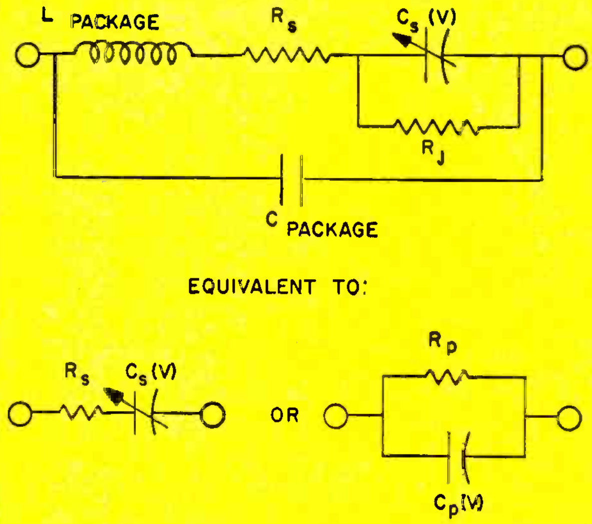


Fig. 1 Equivalent circuit of the voltage variable capacitor can be simplified to an equivalent series resistance and the capacitance which is a function of the applied voltage.

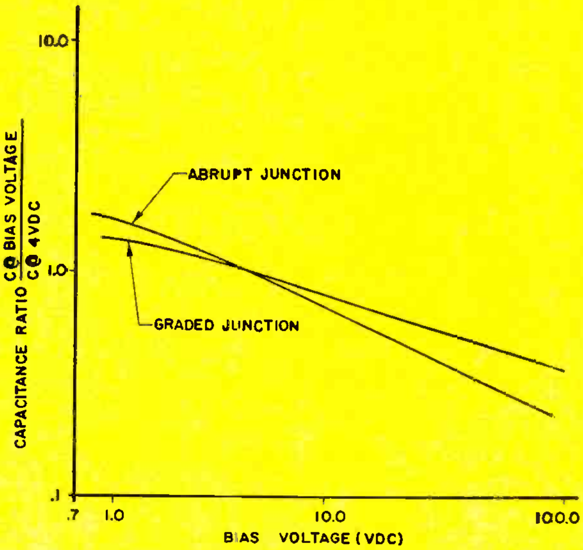
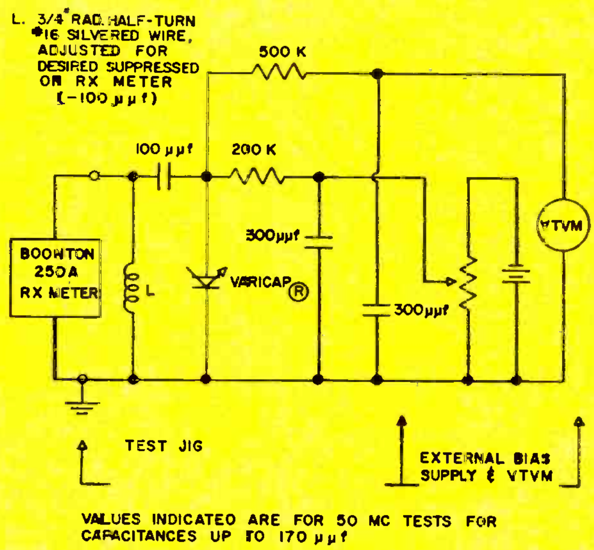


Fig. 2 Capacitance vs voltage relationship for the abrupt junction shows an inverse square root relationship; the diffused junction shows an inverse cube root relationship.

Fig. 3 Test fixture configuration uses a small signal R-X meter to attain unambiguous, reproducible capacitance and Q figures.



Capacitors *(Continued)*

involving the statement of capacitance at voltage of four volts, and of Q factor at a voltage of four volts and a frequency of 50 MC. Capacitance range is stated as a ratio between that at a voltage of one volt and a maximum working voltage of the device.

In testing the variable capacitance devices, it is important to note several pitfalls. One is that a small signal voltage must be used to give accurate indications of capacitance and Q factor because the capacitance is a function of instantaneous applied voltage. This excludes the measurement of high-Q voltage variable capacitors by large signal methods, such as standard Q meters.

Fig. 3 shows a standard test fixture configuration to be used with a small signal R-X meter in order to attain unambiguous, reproducible capacitance and Q figures. Lead-lengths and component positions are important.[3] Inductor L is used to suppress the zero on the R-X meter for measuring devices whose capacitance exceeds 20μμf. The R-X meter indicates the losses of the jig in parallel with the variable capacitance device, and readings must be corrected accordingly. A number of companies and military activities have arrived at this technique by separate routes, indicating that it is indeed the best practical circuit for use with high-G variable capacitors.

TABLE 2

VOLTAGE VARIABLE CAPACITORS PRESENTLY AVAILABLE FOR USE IN LF to UHF APPLICATIONS

Manufacturer and Type No.	Capacitance μμF At 4V DC	Capacitance μμF Approx. Range .1V-MWV	Quality Factor Q (a) At 4V DC 50 Mc/s	Quality Factor Q (a) Typical at MWV 50 Mc/s	Maximum Working Voltage (MWV) Volts DC	Cut-off Frequency Calculated Min. f_c Mc/s (b)	Comments
PSI V-7	7	3.0-18	13 Min.	43	25	650	Types V-7E to V-56E duplicates. Types V-7 to V-56 in initial capacitances, but they have voltage ratings about four times higher and minimum capacitances of one-half as much.
V-10	10	4.3-26	13 Min.	43	25	650	
V-12	12	5.2-31	13 Min.	43	25	650	
V-15	15	6.5-39	13 Min.	43	25	650	
V-20	20	10-50	7.0 Min.	40	20	350	
V-27	27	14-70	7.0 Min.	34	20	350	
V-33	33	17-85	7.0 Min.	31	20	350	
V-39	39	20-100	7.0 Min.	32	20	350	
V-47	47	24-120	7.0 Min.	32	20	350	
V-56	56	32-145	7.0 Min.	25	15	350	
V-68	68	47-210	9.0 Min.	26	15	450	
V-82	82	57-260	9.0 Min.	24	15	450	
V-100	100	57-260	8.0 Min.	20	15	400	
PC-112-10	10	2.4-28	50 Min.	>200 (c)	80	2500	
PC-115-10	10	2.2-28	100 Min.	>200 (c)	100	5000	
PC-113-22	22	5.2-61.5	50 Min.	>200 (c)	80	2500	
PC-116-22	22	4.8-61.5	100 Min.	>200 (c)	100	5000	
PC-114-47	47	11.2-132	50 Min.	>200 (c)	80	2500	
PC-122-47	47	10.7-132	75 Min.	>200 (c)	100	3700	
PC-117-47	47	10.7-132	100 Min.	>200 (c)	100	5000	
HP HC 7001	35	6-88		39	130		
HC 7002	50	12-120		36	80		
HC 7004	70	20-170		30	60		
HC 7005	100	46-240		23	25		
HC 7006	35	14-88		20	25		
HC 7007	50	22-120		20	25		
HC 7008	70	32-170		20	25		
TR SC- 1	10	4.4-24	35 Typ.		22	1750	
SC- 2	20	8-48	35 Typ.		22	1750	
SC- 3	35	15-90	35 Typ.		18	1750	
SC- 5	50	25-120	35 Typ.		11	1750	
SC- 7	70	55-165	35 Typ.		9	1750	
SC-11	105	85-245	35 Typ.		6	1750	
SC-15	150	120-360	35 Typ.		6	1750	
SC-51	0.5	.35-3	100 Typ.		10	5000	
SC-52	1.0	.8-5	100 Typ.		7	5000	
IR	10V DC		10V DC				
6.8SC20	6.8	3-30	37 Typ.		200		
PH		.5V-MWV	.5V DC				
T-1606		8-35	20 Typ.		30		

(a) $Q = 1/\omega R_s C_{4V}$
(b) $f_c = Q_{4V} f$
(c) Beyond Measurement Capability
PSI—Pacific Semiconductors, Inc.
HP—Hughes Products
TR—Transitron
IR—International Rectifier Corp.
PH—Philco

Temperature Stability

One prime disadvantage in the early evolution of the variable capacitance device was that the temperature variation of the internal device contact potential caused a temperature sensitivity of capacitance at voltages in the neighborhood of five volts and below. The evolution of a new technique employing an opposing junction whose temperature-sensitive internal contact potential balances that of the voltage variable capacitance in the device itself has resulted in both the attainment of temperature stability and extending the true power-law range of capacitance versus voltage relationship.

Fig. 4 shows the compensating junction circuit. It should be noted that one compensating junction can be used to compensate the capacitance versus temperature relationship of a number of variable capacitance devices in the same piece of equipment. Upon superficial examination, one might conclude that the balancing of the junction potential can be done without the external constant current bias circuit. The problem is that the contact potentials of any junctions balance at the terminals of the device so that the compensation cannot be obtained without the application of an external bias current. The external current develops a forward voltage drop across the compensating diode, equal in magnitude and opposite in sign to the internal contact potential of the voltage variable capacitor. Compensating junction techniques can reduce the capacitance variation at one volt from a 25% change between 25 and 100°C to a ±2 or 3% maximum change over the same temperature range.

Advanced Applications

Voltage variable capacitors have been used to multiply frequencies with very high efficiencies. Fig. 5 shows the basic circuit of the harmonic generator. The voltage variable capacitor is driven at a frequency "nf." Efficiencies of 40% have been reported in multiplying frequencies from 300 to 900 MC, at hundreds of milliwatt levels, as have efficiencies of 80% doubling from 200 to 400 MC at hundred-milliwatt levels. This technique is especially usable in transferring local oscillator energy to a required high frequency.

Electronic Tuning

Voltage variable capacitors can be used in electronic tuning by acting as the capacitor in an L-C tank circuit. DC bias is applied in order to change the median capacitance about which the small-amplitude intelligence signal varies. Fig 6A shows the basic circuit used for electronic tuning. Fig. 6B shows electronic tuning applying the compensating junction for increasing the tuning range and improving temperature stability in a practical application. Q's now available are appreciably higher than are really required for electronic tuning applications. This is opposed to the relatively low Q's previously available. Tracking problems are not critical in this operation, as the capacitance-voltage relationships are essentially fixed by the physical nature of the abrupt junction device.

(3) The authors will send assembly drawings of the test fixtures on request, in the interest of standardization.

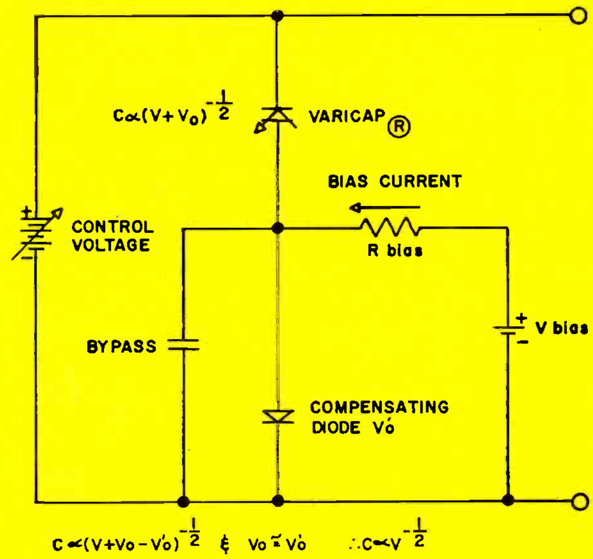


Fig. 4: Compensating Junction circuit for temperature stabilization and extension of capacitance range.

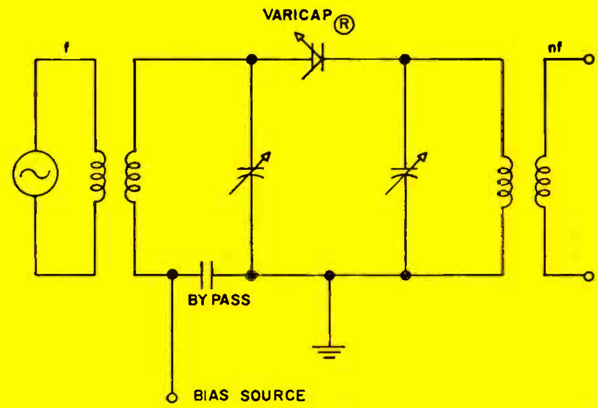
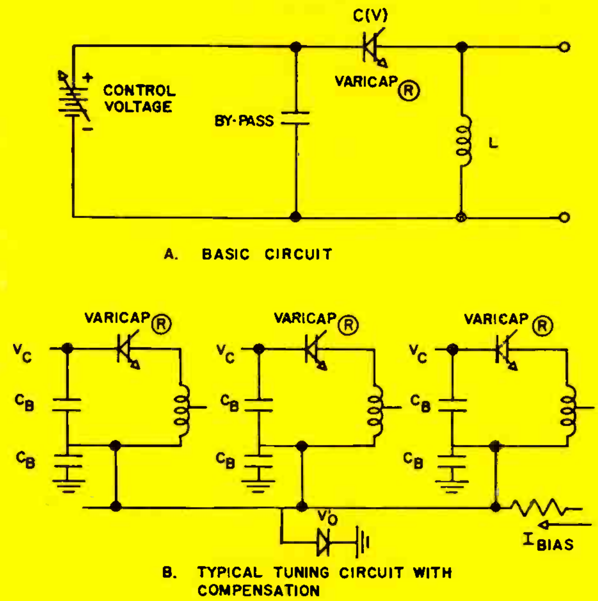


Fig. 5: Basic circuit of the harmonic generator. The voltage variable capacitor is driven at a frequency "nf".

Fig. 6: (top) Basic circuit for electronic tuning. (Bottom) The compensating junction increases the tuning range and improves temperature stability.



Capacitors *(Continued)*

Flip-flop Elements

One promising field of applications which has yet received little study is that of the use of voltage variable capacitors as flip-flop elements. Fig. 7 shows a carrier energized resonance-activated bistable circuit described by E. O. Keizer. It is no doubt possible to construct computer flip-flops using one or two voltage variable capacitors as the active elements. It has been reported that a computer using variable capacitance devices has been constructed in Japan. Very little activity of this sort has been reported in the United States to date. These devices are inherently simpler and less expensive than transistors, and it is quite possible that the smaller, less expensive computers can be developed.

Bibliography

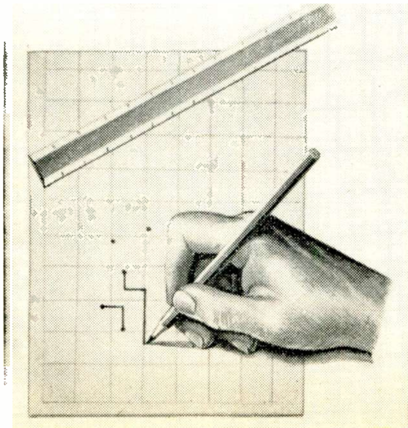
1. K.K.N. Chang and S. Bloom, "A Parametric Amplifier Using Lower-Frequency Pumping," *Proc. IRE*, Vol. 46, pp. 1383-6, July, 1958.
2. K.K.N. Chang, "Harmonic Generation with Nonlinear Reactances," *R.C.A. Review*, September, 1958.
3. F. Dill and L. Depian, "Semiconductor Capacitance Amplifiers," *1956 IRE Convention Record*, Part 3, pp. 172-4.
4. L. J. Giacoletto, "Junction Capacitance and Related Characteristics Using Graded Impurity Semiconductors," *IRE Transactions on Electron Devices*, pp. 207-14, July, 1957.
5. L. J. Giacoletto and J. O'Connell, "Variable-Capacitance Germanium Diode for UHF," *R.C.A. Review*, March, 1956, also Transistors I, pp. 221-38.
6. H. Heffner and K. Kotzebue, "Experimental Characteristics of a Microwave Parametric Amplifier Using a Semiconductor Diode," *Proc. IRE*, Vol. 46, p. 1301, June, 1958.
7. H. Heffner and G. Wade, "Gain, Band Width, and Noise Characteristics of the Variable-Parameter Amplifier," *Journal of Applied Physics*, September, 1958.
8. G. F. Herrmann, M. Uendhara, and A. Uhlir, Jr., "Noise Figure Measurements on Two Types of Variable Reactance Amplifiers Using Semiconductor Diodes," *Proc. IRE*, Vol. 46, pp. 1301-3, June, 1958.
9. E. O. Keizer, "A Carrier-Energized Bistable Circuit Using Variable-Capacitance Diodes," *R.C.A. Review*, pp. 475-85, December, 1957.
10. D. Leenov, "Gain and Noise Figure of a Variable-Capacitance Up-Converter," *Bell Technical Journal*, July, 1958.
11. D. Leenov and A. Uhlir, Jr., "Generation of Harmonics and Sur-harmonics at Microwave Frequencies with p-n Junction Diodes," *Program of the 1958 Electron Devices Meeting*, p. 50, 1958.
12. J. M. Manley and H. E. Rowe, "Some General Properties of Nonlinear Elements," I: "General Energy Relations," *Proc. IRE*, Vol. 44, pp. 904-13, July, 1956.
13. M. E. McMahon and G. F. Straube, "Voltage Sensitive Semiconductor Capacitors," *1958 IRE WECON Convention Record*, Part 3, p. 72, August 19-22, 1958.
14. L. S. Nergaard, "Nonlinear-Capacitance Amplifiers," *R.C.A. Review*, March, 1959.
15. C. H. Page, "Harmonic Generation with Ideal Rectifiers," *Proceedings of the IRE*, October, 1958.
16. W. F. Palmer and D. H. Rice, "Characteristics and Applications of Low-Impedance Diodes Used As Voltage-Variable Capacitors," *IRE Transactions on Broadcast and Television Receivers*, June, 1958.
17. W. Y. Pan and O. Ramanus, "Automatic Frequency Control of Television Receivers Using Junction Diodes," *Transistors I*, pp. 598-608, R.C.A. 1956.
18. E. D. Reed, "The Variable-Capacitance Parametric Amplifier," *IRE Transactions on Electron Devices*, April, 1959.
19. H. E. Rowe, "Some General Properties of Nonlinear Elements"; II: "Small Signal Theory," *Proc. IRE*, Vol. 46, pp. 850-60, May, 1958.
20. B. Salzberg and W. Sard, "A Low-Noise Wide-Band Reactance Amplifier," *Proc. IRE*, Vol. 46, p. 1303, June, 1958.
21. C. J. Spector, "A Design Theory for the Highest Frequency p-n Junction Variable Capacity," *Program of the 1958 Electron Devices Meeting*, p. 54, 1958.
22. G. F. Straube, "A Voltage-Variable Capacitor," (2 parts). *Electronic Industries*, pp. 69-73, May, 1958, and pp. 77-80, July, 1958.
23. Rufus P. Turner, "Using the Varicap," *Radio-Electronics*, Vol. 29, pp. 57-9, May, 1958.
24. A. Uhlir, Jr., "Two-Terminal p-n Junction Devices for Frequency Conversion and Computation," *Proc. IRE*, Vol. 44, pp. 1183-91, September, 1956.
25. A. Uhlir, Jr., "The Potential of Semiconductor Diodes in High-Frequency Communications," *Proc. IRE*, Vol. 46, pp. 1099-1115, June, 1958.
26. A. Uhlir, Jr., "Shot Noise in p-n Junction Frequency Converters," *Bell Technical Journal*, July, 1958.
27. A. Uhlir, Jr., "Junction-Diode Amplifiers," *Scientific American*, June, 1959.
28. R. L. Wigington, "A New Concept in Computing," *Proceedings of the IRE*, April, 1959.
29. M. M. Brady, "Oscillator Design Using Voltage-Variable Capacitors," *Electronics*, August 21, 1959.
30. M. M. Fortini and J. Wilms, "Solid-State Generator for Microwave Power," *Electronics*, September 4, 1959.

'Catalog' Printed Circuits

THE printed wiring board has been reduced to a "catalog" item. Photocircuits Corporation, 31 Sea Cliff Ave., Glen Cove, N. Y., offers drilled quantities of any reasonable size board, any pattern and hole configuration, a choice of platings and base materials, all without a tool charge, without need of artwork, and at a competitive piece price.

Artwork is the starting point in producing printed wiring panels designed to specific needs. This is all that has to be done.

"True" size circuit is drawn on Mylar.



1. On a sheet of gridded mylar, printed with X and Y coordinates over a photographically non-reproducible 1/10 grid matrix, carefully draw the circuit, "true" size with a sharp pointed pencil.

2. Each place a hole and an associated "land" area is desired, show its location by drawing a small circle "o". Tables of standard hole sizes and associated "land" dimensions are available.

If no land is desired around a hole, use the letter "N" next to the hole designated.

3. Draw lines parallel to the X-Y axes lines wherever possible. The lines should coincide with the 0.100-in. lines; however, it is permissible to draw conductor lines mid-way between the gridded lines allowing increments of 0.050 in.

4. Conductor widths come in three standard dimensions. They are: 0.031 in., 0.062 in., and 0.125 in., designated as I, II, and III numeral.

5. Draw the edges of the board parallel to the X-Y coordinates. Edge tolerances are held to ± 1/32 in. without tool charges. A jig or router plate will cause additional expense for closer tolerances.

6. If a printed legend on the finished circuits is needed, show such characters marked in red, on a blueprint or verifaxed copy—not on the mylar sheet.

7. To show a standard finger layout for a plug-in. board, try to conform to the industry's standard of fingers with the dimensions between finger center lines of 0.156 in. The dimension between the center line of the first finger and the adjacent edge of the plug-in board must be shown. The standard tolerance on this dimension is ±0.015 in.

A simple and accurate method of measuring the ratio h_{11}/h_{12} is used in synthesizing the neutralization circuit. Complex plane techniques, by which the circuit operates over a wide band, are used in designing an amplifier with a pass band of from 15 to 25 MC.

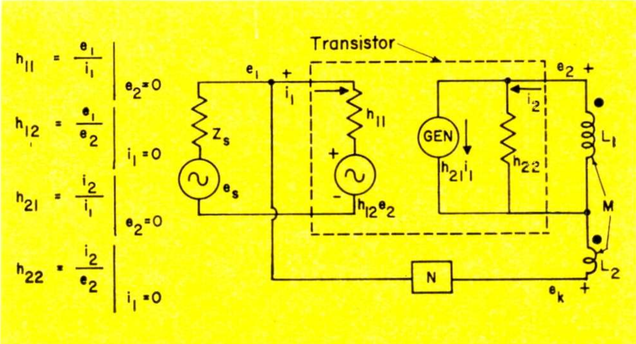


Fig. 1: This circuit is analyzed to determine the value of N.

Neutralizing Wide Band H-F Transistor Amplifiers

By RICHARD E. LESLIE
Engineer, Airborne Instruments Laboratory
Mineola, New York

and DONALD T. HESS
Instructor, Polytechnic Institute of Brooklyn
Brooklyn, New York

RICHARD E. LESLIE and DONALD T. HESS were affiliated with Sperry Gyroscope Co. when this article was prepared.

IN the past several years neutralization of transistors for use in tuned amplifiers has received considerable attention. The reasons for neutralization have been discussed previously and are well known.[1,2]

In general, most transistor circuits today are neutralized by one of two methods: h-type neutralization or y-type neutralization. H-type neutralization, which is considered best for wide band amplifiers, is difficult to derive without a complete knowledge of the transistor equivalent circuit. On the other hand, y-type neutralization is considered inferior to h-type since it does not neutralize as well over an entire band once it is derived at a particular frequency.[2]

In this article, a method is developed for making y-type neutralization wide band. This is accomplished, without a complete knowledge of the transistor equivalent circuit, by a straight-forward analysis and with a simply measured set of transistor parameters.

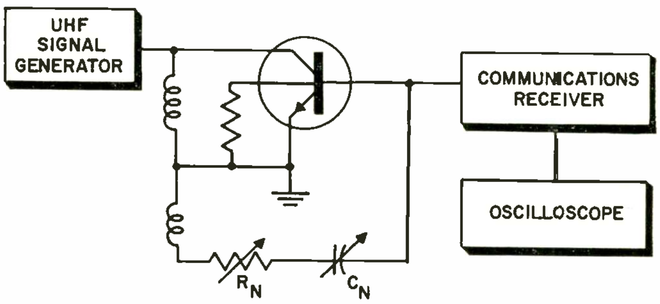
Y-Type Neutralization

The following analysis is made on a common emitter stage, but the problem is similar for common base amplifiers. The only difference is that y-type neutralization for common emitter stages must be made with the aid of an inverting transformer because of the nominal 180° phase shift through the transistor. The transformer is separated from the neutralizing circuit in the analysis.

Fig. 1 shows the circuit which is analyzed to determine the value of N, the neutralizing network. Conventional hybrid parameters, h_{11}, h_{12}, h_{21}, and h_{22} are used to represent the transistor, and N is expressed as a function of these. It will be shown, however, that only the ratio h_{11}/h_{12} need be determined for specifying N.

(Continued on following page)

Fig. 2: Experimental circuit used to determine N at any frequency.



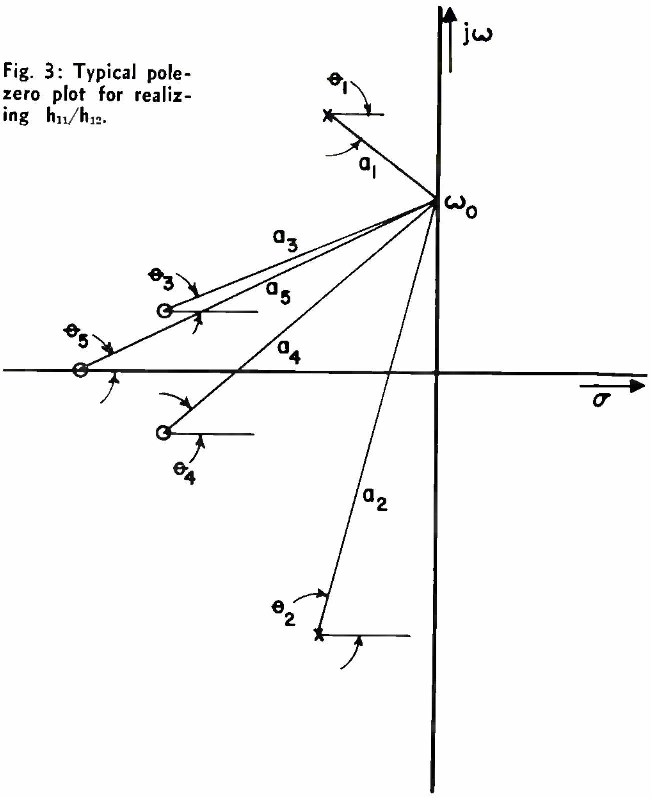


Fig. 3: Typical pole-zero plot for realizing h_{11}/h_{12}.

Neutralization *(Continued)*

If a transistor is completely neutralized, the input voltage e_1 is independent of the output voltage e_2. The criterion for this condition is best seen by employing the principle of superposition. Assuming linear transistor parameters, e_1 is a linear function of e_s, e_2, and e_k; accordingly

$$e_1 = Ae_s + Be_k + Ce_2 \quad (1)$$

$$e_k = De_1 + Ee_2 \quad (2)$$

where:

$$B = \frac{e_1}{e_k}\bigg|_{e_s = e_2 = 0} \qquad D = \frac{e_k}{e_1}\bigg|_{e_2 = 0}$$

$$C = \frac{e_1}{e_2}\bigg|_{e_s = e_k = 0} \qquad E = \frac{e_k}{e_2}\bigg|_{e_1 = 0}$$

$$A = \frac{e_1}{e_s}\bigg|_{e_k = e_2 = 0}$$

By substituting Eq. 2 in Eq. 1 the following is obtained

$$e^1 = \frac{Ae_s + (BE + C)e_2}{1 - BD} \quad (3)$$

But for e_1 to be independent of e_2, $(BE + C)$ must equal zero. Now it is seen by referring to Fig. 1 that

$$B = \frac{e_1}{e_k}\bigg|_{e_s = e_k = 0} = \frac{Z_s\, h_{11}}{P.\,S.}$$

where $P.\,S. = Z_s\, h_{11} + N\, h_{11} + N\, Z_s$

$$C = \frac{e_1}{e_2}\bigg|_{e_s = e_k = 0} = h_{12}\,\frac{NZ_s}{P.\,S.}$$

$$E = \frac{e_k}{e_2}\bigg|_{e_1 = 0} = \frac{NM}{s\,(M^2 - L_1\,L_2) \; - L_1\,N}$$

Where s is the complex frequency $\sigma' + j\omega$. Substituting the above quantities into Eq. 3

$$\frac{NZ_s}{P.\,S.} = \frac{-\,Z_s\,h_{11}}{P.\,S.}\;\frac{NM}{s\,(M^2 - L_1\,L_2) - L_1\,N}$$

and solving for N now yields

$$N\,(s) = \frac{W\;h_{11}\,(s)}{L_1\;h_{12}\,(s)} - L_2\,s\,(1 - K^2) \text{ where } K = \frac{M}{\sqrt{L_1\,L_2}} \quad (4)$$

Realization of N

The negative term $L_2s(1\text{-}k^2)$ appears to make N unrealizable. But, if h_{11}/h_{12} is synthesized by a ratio of polynominals in s containing one more zero than pole, N is entirely real, providing the coefficient M/L_1 is chosen properly.

At this point it is clearly seen that the only quantity that need be obtained by measurements on the transistor is h_{11}/h_{12}. It should be noted though that h_{11}/h_{12} must be determined as a function of frequency over the entire band of interest to adequately determine N.

A method for experimentally determining the ratio h_{11}/h_{12} directly is suggested by solving Eq. 4 for this quantity.

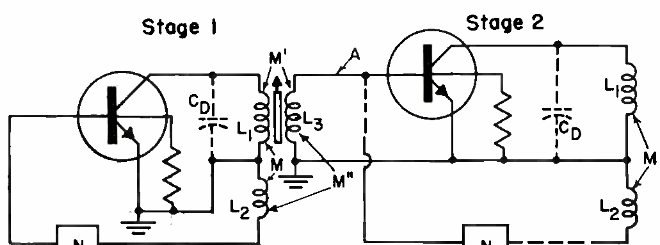
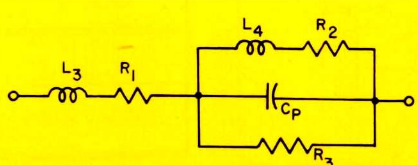


Fig. 5: Partial interstage circuit showing mutual inductances.

$$\frac{h_{11}}{h_{12}}\,(s) = [N'\,(s) + L_2\,s\,(1 - K^2)\,]\,\frac{L_1}{M}$$

It can be seen that if a number of N' (s) are found which provide neutralization at a corresponding number of frequencies in the band of interest, (h_{11}/h_{12}) (s) is determined as a function of frequency, assuming the transformer parameters are known.

A consideration of the internal feedback mechanism of a transistor shows that substituting a series R-C circuit for N neutralizes at any one frequency, but not necessarily over the entire band.[1] Thus, a calibrated resistor and capacitor, placed in the feedback network and adjusted to provide neutralization at several frequencies in the band, determines the variation with frequency of the magnitude and phase of N', and in turn h_{11}/h_{12}, over the band. Fig. 2 shows



IN TEXT; L_3=a, R_1=b, R_3=$\frac{1}{d}$, R_2=f, L_4=e, C_p=c

Fig. 4: Network with the pole-zero plot shown in Fig. 3.

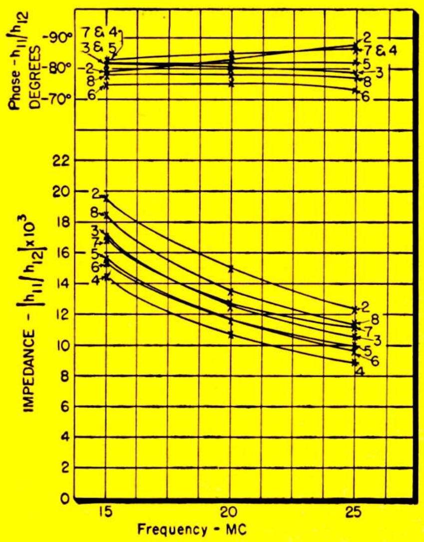


Fig. 6: Magnitude and phase plot for h_{11}/h_{12} over a 10 MC band.

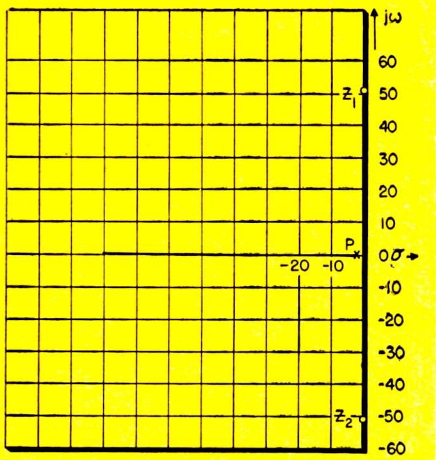


Fig. 7: Pole-zero plot of impedance plot which realizes h_{11}/h_{12}.

the experimental circuit used to determine N at any given frequency.

When the series R-C network comprising N' is properly adjusted, a null is produced at the radio receiver and observed on the oscilloscope. In this manner at least a thousand to one reduction in feedback voltage may be achieved at any one frequency by properly adjusting the calibrated resistor and capacitor.

Physical Components

The above experimental technique gives (h_{11}/h_{12}) (s) as a function of frequency. However, it does not provide any indication of the physical nature of components that could generate such a function.

To determine the value of these physical components, zero-pole techniques are used. First, a ratio of polynominals in s in which the number of zeros is greater than the number of poles by one must be found to approximate h_{11}/h_{12} in magnitude and phase. Fig. 3 shows one possible pole-zero plot of the required function (h_{11}/h_{12}) (s) $=$ $[(s\text{-}z_2)$ $(s\text{-}z_4)$ $(s\text{-}z_5)]/[(s\text{-}p_1)$ $(s\text{-}p_2)]$. The magnitude of this function is $(a_3\ a_4\ a_5)/(a_1\ a_2)$ and the phase is $(\theta_3 + \theta_4 + \theta_5) - (-\theta_1 + \theta_2)$. The quantities may be readily measured with dividers and protractor when the pole-zero plot is to scale. Therefore, the effect of shifting any singularities to better approximate (h_{11}/h_{12}) (s) is easily determined.

With this method of graphically shifting poles and zeros to approximate (h_{11}/h_{12}) (s) no lengthy calculations involving impedances need be made. In addition, an exact mathematical representation would be impossible since an infinite number of restrictions would have to be placed on a finite number of equations. Certain restrictions must be made on the pole-zero placement so that the quotient for (h_{11}/h_{12}) (s) is entirely positive, i.e., when $(s\text{-}z_3)$ $(s\text{-}z_4)$ $(s\text{-}z_5)$ is divided by $(s\text{-}p_1)$ $(s\text{-}p_2)$, p_2, z_2, z_3, z_4 must be adjusted so that all terms in the quotient are positive.

Dividing out the above expression for (h_{11}/h_{12}) (s) gives an impedance of the form $as + b + (1/cs) + d + [1/(es + f)]$ for three zeros and two poles. The corresponding general circuit is shown in Fig. 4. If M/L_1 is properly adjusted, the inductor (M/L_1) L_3 cancels $-L_2$ $(1\text{-}k^2)$ in Eq. 4, which reduces N to the following form

$$N = b + \cfrac{1}{e'\,s + d' + \cfrac{1}{e'\,s + f'}} \qquad (5)$$

Usually, it is found that some of the components comprising N are negligible and can be eliminated. In some cases a fewer number of poles can be used. This is especially true if the bandwidth is narrow, and if the plot of h_{11e}/h_{12e} is a smoothly varying function.

Neutralizing Transformer

Several factors must be kept in mind when designing the feedback transformer. M should be made

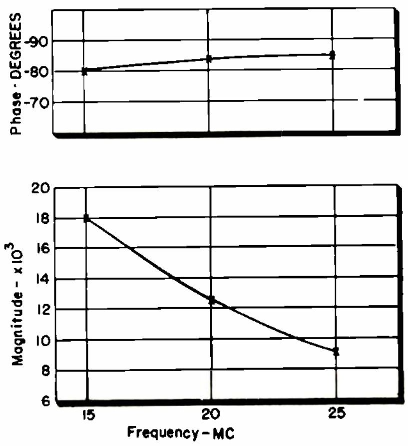


Fig. 8: Magnitude and phase shift of impedance represented by pole-zero plot of Fig. 7.

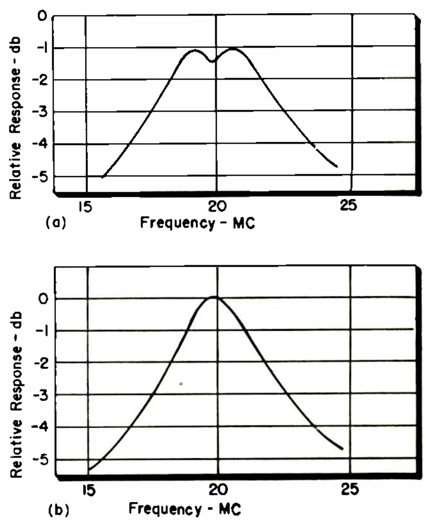


Fig. 9: Response at point A in Fig. 5, with stage 2, (a) unneutralized and (b) neutralized.

Neutralization *(Concluded)*

small in order to minimize the effect of loading on the primary. This also permits the use of small impedances in the neutralizing network, which decreases the effect of stray capacity in the feedback path.

In general, the primary of the feedback transformer is also made the primary of an interstage transformer as is shown in Fig. 5. If this is the case, M'' is made as small as possible so that the above theory applies without modification.

Application of Derivatives

The first step for applying the above theory is the measurement of h_{11}/h_{12}. Fig. 6 shows the plot of magnitude and phase for h_{11}/h_{12} over a 10 MC band as determined experimentally for eight high quality silicon transistors with a β cutoff of about 30 MC.[3,4] The pole-zero plot which yields a magnitude and phase characteristic approximating the mean value of h_{11}/h_{12} for all the transistors is shown in Fig. 7. In this case, the variation of h_{11}/h_{12} with frequency was such that two zeros and one pole was sufficiently accurate. Plots of phase and magnitude for the pole-zero configuration are shown in Fig. 8, normalized with respect to the transistor data curves by means of a scale factor.

The scale factor which is introduced to make the magnitude curves of Figs. 8 and 6 coincide also determines the magnitude of the components in the feed-back network. With only the singularities shown in Fig. 7, Eq. 5 reduces to the form $(1)/(cs + d)$ when M/L_1 is adjusted properly. The network for N which finally results is a 20 µµf capacitor in parallel with a 4.7k resistor. To account for the different transistor characteristics, a variable capacitor is necessary to provide a fine adjustment.

This network, with the variable capacitor adjusted to suit each transistor, reduced the feedback by a factor of at least ten to one over the entire 10 MC band, and at most frequencies, reduced the feedback by a factor greater than 200 to 1.

Fig. 9a shows the response at point A in Fig. 5 to a swept frequency when stage number 2 is unneutralized and both stages are tuned to the same frequency.

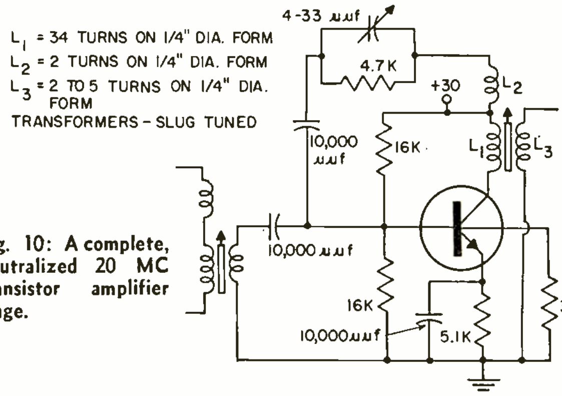


Fig. 10: A complete, neutralized 20 MC transistor amplifier stage.

The dip at the center of the resonance curve indicates a radical change in input impedance of the unneutralized tuned stage.

Fig. 9b shows the response of the same point when the neutralization network is added and the resonant circuit center frequencies are unchanged. From this experimental test it is seen that the neutralization network derived above is effective. These neutralized stages may now be stagger tuned since the tuning of one stage has little effect upon the resonant response of the preceding stage. Fig. 10 shows a complete neutralized amplifier stage.

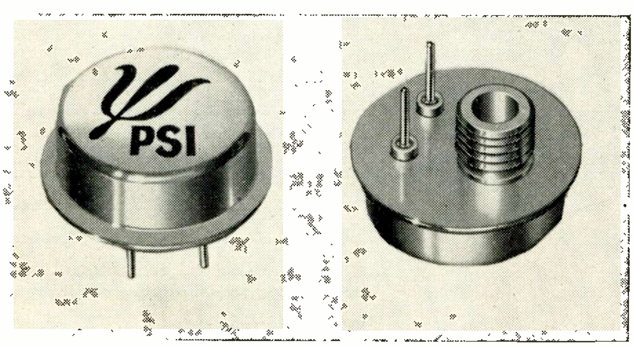
Acknowledgement

The authors are indebted to Mr. J. Walters of the Sperry Gyroscope Company for his assistance in the experimental phases of this work. The support of the United States Air Force in conducting this work is gratefully acknowledged.

References

1. Chu, Y. Y., "Unilateralization of Junction Transistor Amplifiers at High Frequencies," *Proceedings of the IRE*, Vol. 43, pp 1001-1006, August 1955.
2. Stern, A. P., Aldridge, C. A., and Chow, W. F., "Internal Feedback and Neutralization of Transistor Amplifiers," *Proceedings of the IRE*, Vol. 43, pp. 838-847, July 1955.
3. Stewart, R. F., Cornelison, B., and Adcock, W. A., "High Frequency Tetrodes," *IRE Convention Record*, Part 3, Electron Devices and Receivers, Vol. 4, pp. 166-169, 1956.
4. Stewart, R. F., "High Performance Silicon Tetrode Transistors," *Proceedings of the IRE*, Vol. 45, p. 1019, July 1957.

High Power Transistor



A very high power, very high frequency, triple-diffused silicon Mesa transistor signalled a technological breakthrough, according to Dr. Harper Q. North, President of Pacific Semiconductors, Inc., a subsidiary of Thompson Ramo Wooldridge, Inc. The device, developed under a 2½ yr. USAF contract in a R & D program at PSI, is being delivered to the USAF in evaluation quantities. Dr. John W. Peterson, Dir. of R & D, and Mason Clark, Head of Development, guided the program.

The unit operates at 10 MC with 202 watts input and 110 watts output. Test operating voltage was 45 volts at 4.5 amps. Water cooled, it is 1 in. in diameter and has an above chassis height of ⅜ in. It will not be commercially available for several months.

Two methods of manufacture are presented: the laboratory procedure detailed fully; the industrial process outlined briefly. The former, successfully developed by the author, provides units suitable for investigative experiments.

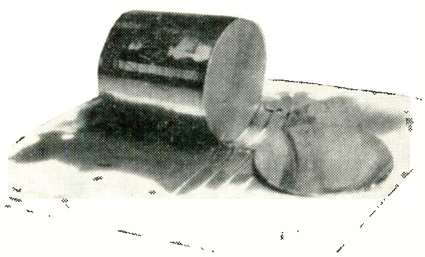


Fig. 1: Germanium crystal is shellac-mounted on tile for easy diamond saw slicing. One of the slices is on the right.

For Lab and Plant . . .

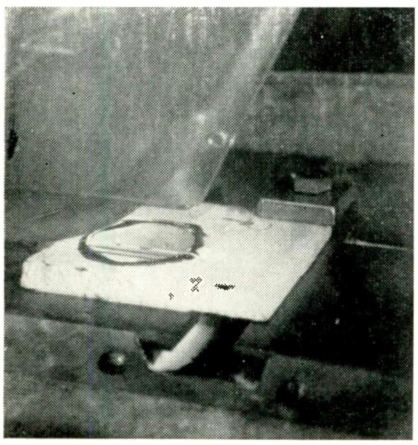
Producing the Tecnetron

By DR. A. V. J. MARTIN
79 Rue Duhesme
Paris 18, France

MANUFACTURE of the tecnetron*, a semiconductor using the field effect is easy. This is all the more so when mass production is not envisioned—a few laboratory samples for experiments being desired.

* The tecnetron was invented by M. S. Teszner at the French Post Office Labs. (CNET).

Fig. 2: Slice is now mounted flat and the diamond saw cuts it into small bars.



Laboratory Production

Hand - made tecnetrons have larger dimensions than industrial ones. However, they do allow one to investigate the possibilities of the device. Moreover, with experience it becomes possible to make smaller and smaller elements, approaching in size the industrial types.

An n-type germanium crystal, between 1 and 10 ohms, can be used. Using the laboratory diamond-loaded saw, a slice, about 1 mm thick, is cut. This slice is then cut into small rods, about 1 mm wide and 6 mm long, Fig. 2.

DR. A. V. J. MARTIN was formerly with the Dept. of Electrical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. He has now returned to his native country where he has resumed work in the electronic engineering editorial field.

Ed.—The tecnetron was first reported in Electronic Industries in March, 1958, p. 78. More detailed information was presented in the July, 1958, issue on p. 120. It is suggested that readers refer to these two items for technical characteristics of the device.

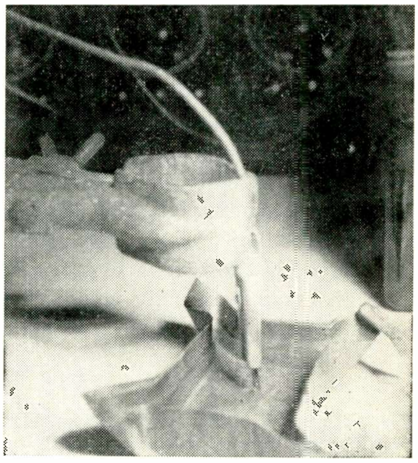


Fig. 3: Ends of each bar are copper plated in a small copper tank prior to tinning.

Cutting operations are greatly facilitated if the germanium crystal and slice are glued to a supporting piece of tile, Fig. 1, with the help of shellac flakes and an electric hot plate.

The germanium rods, easily detached from the tile plate, are thoroughly cleaned in alcohol and left in it until used.

The first process is copper-plating the ends for easy source and drain ohmic contacts, Fig. 3. While

Tecnetron Production *(Continued)*

this entails risks of contamination by migrating copper, it is good enough for laboratory tests. A standard acid plating solution, using copper sulphate, is prepared. A small plating tank about 2 in. square, is made by folding a piece of copper sheet. The rod is suspended by an aligator clip so that its end dips about 1 mm in the plating bath. A dc voltage is applied, the negative pole being connected to the rod and the positive pole to the plating tank. The voltage is then adjusted for a current flow of a few milliamperes. As plating progresses, the original black end of the rod takes on a bright copper red color.

The process is repeated for the other end, then both ends are tinned with the help of a pencil type soldering iron. Do not heat more than necessary for easy soldering and remove iron as soon as solder flows.

Tecnetron supports are made by drilling 3 small holes through a ½ in. piece of ½ in. polystyrene rod, and pushing through the holes three 2 in. lengths of tinned copper wire. Use a drill which will ensure a hard snug fit, or polystyrene dope to glue the wires solidly in place.

The wires should protrude ½ in. on the tecnetron side. Two of them are bent to fit the length of the rod, their tips are tinned, and the rod is quickly soldered to the wires.

This assembly is then dipped 2 or 3 times in melted beeswax tecnetron down, up to the polystyrene piece. Allow time to cool between dips, so as to obtain a good coating of wax.

Then, using a razor blade, scrape off the wax on a length, about 1 mm, to expose the germanium.

Etching

Immerse the tecnetron in CP4, no more than necessary for the germanium rod to be fully covered, Fig. 4. Except for the scraped off part, all parts dipping into CP4 should be well protected by the wax coating.

CP4 is prepared by mixing together the following ingredients in an inert plastic container. Do not use a glass container.

HNO_3	25	cc
CH_3 COOH	15	cc
HF	15	cc
Br_2	0.3	cc

The last one, bromine, takes some time to dissolve entirely. All chemicals indicated are available in most chemical supply stores, as well as suitable containers.

CP4 is a very active etchant for germanium. Be careful to operate under a fume hood, and with caution. CP4 fumes are dangerous.

CP4 cannot be put into glass containers. A convenient expedient is to employ the small polyethylene containers used to make single ice cubes. Pour about ¼ in. of CP4 into it. Then the tecnetron is placed upside down in the small tank and stands on the bottom. Bubbling on the exposed part of the germanium will show that CP4 has begun to work. The process should preferably be followed under a magnifying lens or microscope, and stopped when the remaining filament of germanium is 0.1 mm or less in diameter, Fig. 5. This is roughly hair diameter.

It would be just as well, at least for the first trials, not to go down to such a small diameter. The semiconductor filament becomes excessively fragile, and the field effect can still be obtained with larger diameters. Also, the filament will but rarely have a cylindrical shape. The indicated diameter applies to its narrowest part.

To stop etching, remove the tecnetron from the CP4 and immerse it in distilled water. Rinse freely, and leave in distilled water until taken to the indium or tin plating bath.

For indium plating, several solutions may be used. Most call for not too readily available indium salts.

Indium chloride can be prepared by dissolving small pieces of indium in hydrochloric acid, and boiling off the acid to precipitate the salt. The plating solution is then made by dissolving the salt in distilled water and adding a few drops of acid.

Fig. 4: Exposed portion of bar, mounted on its support, is now immersed in etchant.

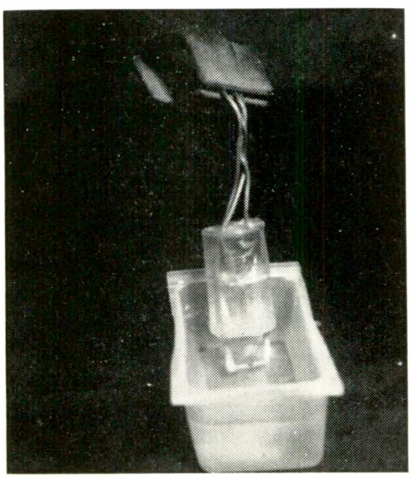


Fig. 5: After etching, remaining filament is so thin that it can hardly be seen.

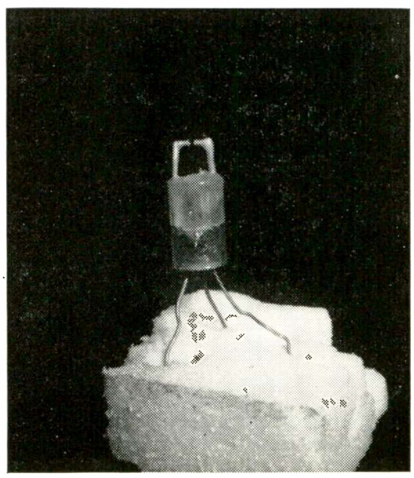
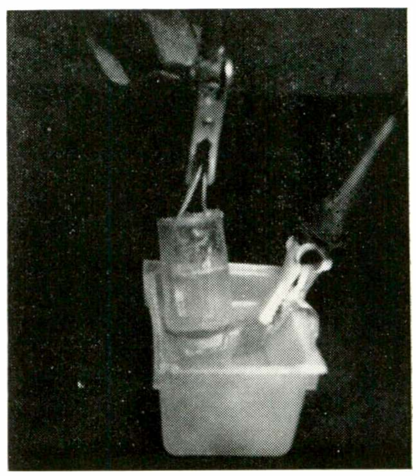


Fig. 6: Indium plating is applied in a small tank. The indium foil acts as anode.



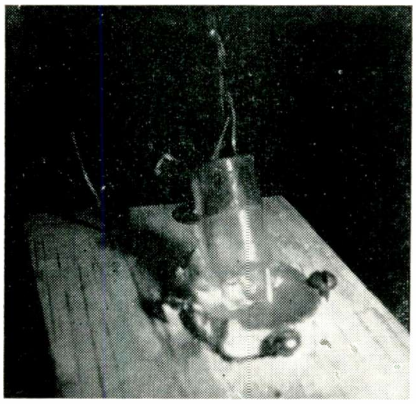


Fig. 7: Alternatively, tin plating is applied in a small tank of hammered sheet.

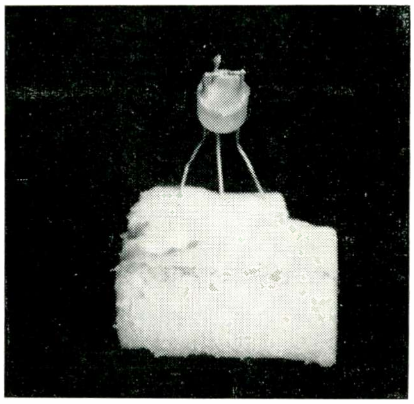


Fig. 8: Small diameter wire makes spring contact on the plating in the groove.

Plating

The plating tank may again be one single ice cube container. A piece of pure indium foil is used as the anode. The tecnetron is immersed in the plating solution, Fig. 6. An adjustable voltage power supply is used, its positive terminal connected via an alligator clip to the indium and the negative terminal connected in the same way to the two end wires of the tecnetron. A meter is necessary to control the current, which should not exceed 25 μa.

Tin plating is relatively easier to apply. The tank is made by folding a piece of tin sheet, or by hammering a piece of bulk tin, Fig. 7. The tank itself is used as the anode. A gallon of standard tin plating solution consists of (all weights avoirdupois):

Sodium stannate	12 oz.
Sodium hydroxide	12 oz.
Sodium acetate crystals	2 oz.

The current should not exceed 25 μa, and the plating tank should be kept at 60°C, approxi., for best results. This can be done by setting the tank on an adjustable electric heater.

The plating process should preferably be controlled with the help of a magnifying lens or microscope. The current values indicated give a smooth plating, but the process is slow. However, once the exposed surface of germanium is completely plated, the current might be increased to 50 or even 100 μa to build up thickness more rapidly.

Once the plating is completed, and this may take several hours at low current densities, the tecnetron is thoroughly washed in distilled water.

An optional step is to dissolve the wax away in some standard solvent like toluene to obtain a better looking end product, then wash the tecnetron with alcohol, and immerse it for a few seconds in CP4.

Anyhow, the third wire is scraped clean, and a ½ in. length of small diameter bronze or nickel wire, or any other springy metal, is soldered to it. The wire is then carefully adjusted so as to obtain a spring contact on the plating, Fig. 8.

Another optional step is soldering of this gate contact.

To check the important part of the tecnetron, e.g., the rectifying gate contact, measure its resistance both in the forward and reverse directions. A ratio of 10^3 is poor, a ratio of 10^6 is excellent.

For mechanical protection, the experimental tecnetron may be encased in plastic or glass tubing.

Industrial Production

To avoid unwanted carrier injection at the source end, the germanium bar used in the industrial process does not have constant resistivity.

When making the germanium crystal it is first pulled as an n-type of 15 ohms resistivity; then arsenic doping is added to obtain an N+ part of 0.05 ohms resistivity. A slice is cut including N and N+ germanium, Fig. 10.

Then a special tool, driven by ultrasound, is pushed onto the crystal and, in one pass, cuts simultaneously 30 small bars. These bars are detached from the sole of the slice, Fig. 11, and are fixed on a rotating machine with the help of two spring loaded clips.

These clips are connected to an ohmmeter, so that the resistance of the bar is continuously controlled during processing, Fig. 12.

The bar is rotated, and a thin jet of electrolyte hits it at about one third of its length. The electrolytic etching creates a groove approximately 40 microns wide. When the diameter of the remaining permanium reaches 40 microns, etching is automatically stopped and another jet starts hitting the groove. It is an indium plating jet, depositing indium in the groove.

When the plating is completed, the gate contact wire is soldered by a capacitor discharge method. This ends the manufacturing processes of the tecnetron proper.

It is subsequently mounted in a standard transistor case, Fig. 9. As this limits the high frequency performance, a better arrangement is being developed.

Notice that the method of manufacture ensures a high degree of reproducibility, as well for the geometrical as for the electrical characteristics.

Most of the techniques used for

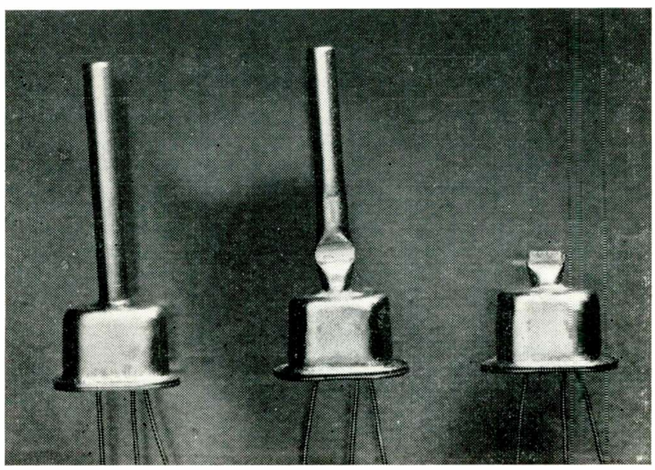


Fig. 9: Commercially produced units are encased in a standard transistor casing.

Fig. 10: Industrial bars are doped so that slices include N and N+ germanium.

Tecnetron Production *(Concluded)*

industrial production can evidently be adopted in laboratory production. Such are the impurity gradient in the semiconductor, the electrolytic machining of the groove, the resistance control, and the soldering of connections by capacitor discharge. All of them, however, call for some degree of experience in the field.

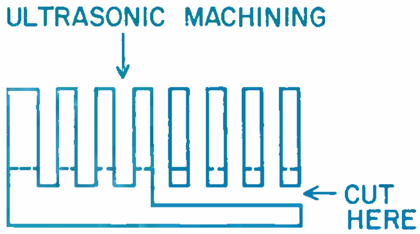


Fig. 11: Ultrasonic tool cuts 30 small bars from the crystal in just one pass.

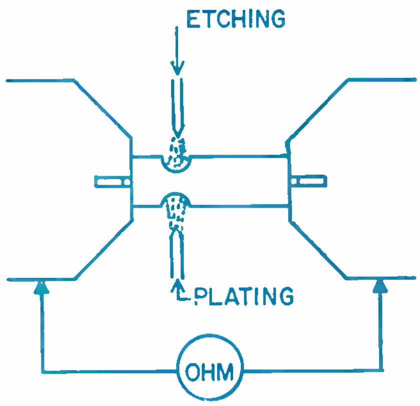


Fig. 12: This set-up continuously controls resistance of the bar during processing.

Continuous Reading Meter Relays

METER-RELAYS with a new design principle, retaining the reliability of locking contacts but providing instantaneous reset, have been developed by Assembly Products, Inc., Chesterland, Ohio.

With the new CR (Continuous Reading) design, the moving pointer shows the signal level at all times, even when the set point has been passed and control circuits have been energized. The circuits remain operative until reset calls for opposite action.

The new design greatly simplifies the circuitry used.

As in present meter-relays, a separate coil increases control dependability by boosting contact torque at set point and thus insuring positive actuation of a load relay.

In applications using the new CR meter-relay, control action is directly linked to the signal and is therefore much smoother, faster and more foolproof than was formerly possible. Since "sampling" the signal is not necessary, a number of auxiliary control components can be eliminated.

Key to the new design is a V-shaped toggle, with contacts on each of its arms. The toggle is pivoted on the under side of the adjustable pointer that marks the set point. Both the toggle and the adjustable pointer are made of layers of isolated metal that are parts of separate circuits from the respective toggle contacts.

When the indicating pointer reaches set point, a two-stage action occurs, almost instantaneously:

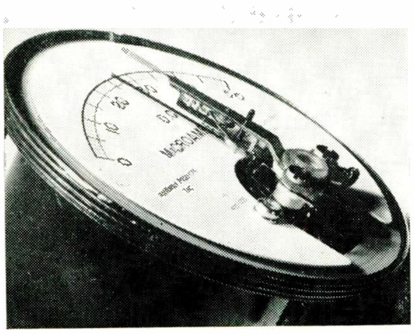
1) A contact on the pointer touches a contact on the toggle and a circuit is closed through both the booster coil and the coil of a multipole load relay. The booster coil assures firm meter-relay contact action.

2) As the load relay initiates the desired control action through one set of contacts, another set closes and pulls a surge of current through the meter-relay movement. Enough torque is thus added to the indicating pointer to cause it to snap the toggle and move past it. The meter-relay contacts are then separated and the booster circuit is opened. This sequence of action may begin at either high or low limit.

The load relay remains energized as long as the signal is higher (or lower) than set point. The indicating pointer moves freely with fluctuating signal strength.

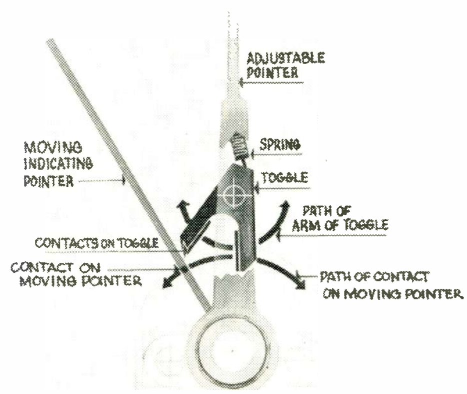
When the indicating pointer returns to set point, its contact again touches a contact on the toggle. A circuit including the booster coil is closed and the load relay is dropped out. The indicating pointer snaps

(*Continued on page* 170)



(Left) Control action begins when a round vertical contact on the indicating pointer meets a flat contact on the toggle mounted beneath adjustable pointer.

(Right) Action of indicating pointer and toggle is revealed in this drawing.



Page from an Engineer's Notebook

#51 Average Heat Dissipation in Transistors & Diodes

By W. F. PALMER
and W. FINNEAULT
Semiconductor Div.
Sylvania Electric Products, Inc.
Woburn, Mass.

THE semiconductor circuit design engineer must often estimate the average operating dissipation of a transistor or diode in order to determine whether the device application is permissible, i.e., within ratings.

Mathematical integration(s) of the instantaneous product(s) of voltage(s) and current(s) may occasionally be practical with simple waveforms, and the graphical (time-domain) method is well known. Both are difficult, tedious, inaccurate and very undesirable when repetitive determinations are to be made, especially when complex or variable waveforms are encountered.

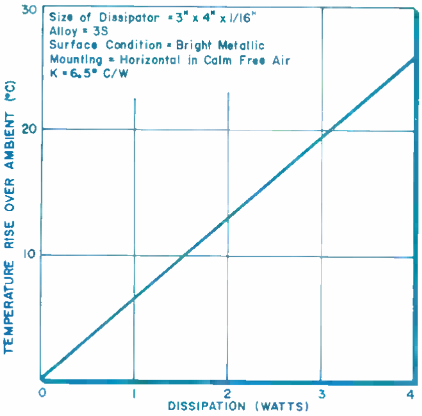


Fig. 1: Calibration curve for dissipator

However, a practical method analogous to the use of a series resistance* in measuring current may be used to determine average dissipation conveniently and accurately, meanwhile including all dissipation components (as, for example, emitter, collector, and base dissipations in transistors or forward and reverse dissipation in diodes).

This technique requires only that the temperature rise vs. dissipation characteristics of a suitable cooling structure be known. These can be readily determined by dissipating known amounts of power in a semiconductor device suitably mounted upon it. This is done by applying direct-current biases to a transistor or diode of the type to be tested. This method allows for any heat directly dissipated by the device itself. In many cases, this factor is negligible and a dissipating structure may be calibrated with any convenient device and used to measure dissipation in other devices having different package configurations. For example, the cooling fin discussed below may be used to measure dissipation in many diode and transistor types having a variety of envelopes. If an additional dissipator is not necessary, the case of the transistor or diode itself may be calibrated.

To illustrate this method, the calibration curve of a 3 x 4 x 1/16 in. aluminum plate is shown in Fig. 1. This is quite linear, since radiation makes little contribution to cooling the bright metallic surfaces in the temperature range shown. This curve was obtained in free, calm air**. Note that the temperature rise above ambient is plotted as a function of power discipation.

The temperature is best measured near the center of the dissipator or where the calibrating and test devices are mounted. Figure 2 illustrates the mounting of the test device and the temperature measuring thermocouple.

To determine the average dissipation in the test device, it is mounted on the dissipator and operated until thermal equilibrium is reached. The temperature rise of the dissipator, over its ambient, is determined and the average dissipation read from its calibration curve.

Knowledge of:

1. Expected ambient conditions.
2. Thermal rise coefficients of:
   (a) dissipator above ambient;
   (b) device case above dissipator;
   (c) device junction above its case.
3. Peak as well as average dissipation.
4. Various thermal time constants will allow decisions to be made regarding permissibility of the application in terms of device ratings.

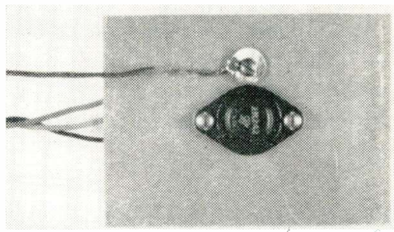


Fig. 2: Test device mounted in dissipator

In practice, a variety of calibrated cooling structures, of different shapes, sizes, thicknesses, orientations, and surface preparations, may be accumulated and used for the purpose discussed, or a basis for determining practical dissipator designs which may be refined for circuit protype use.

* More exactly, of a capacitively bypassed resistance.

** If a suitable location is not available, the dissipator may be calibrated and used in the center of a large box. One side, as the top, may be left open unless the location is unusually drafty.

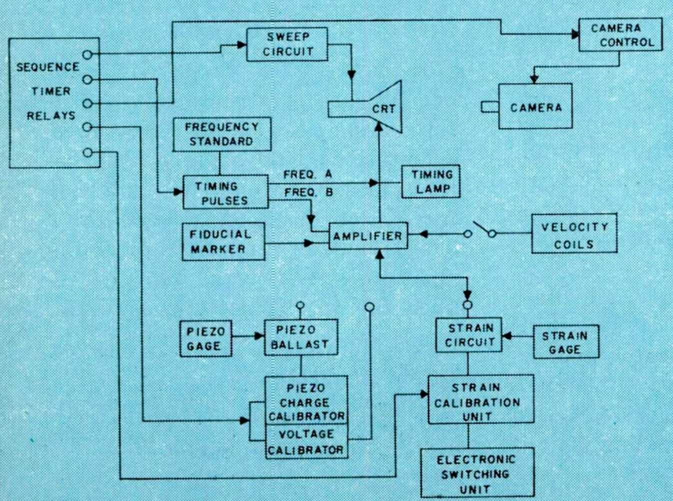
The dynamic strain calibrator was designed for use with a recording system to obtain data for ordnance equipment design. The calibrator described serves to calibrate the recording system for oscillogram deflection vs. change in resistance of gage. Calibrator consists of two parts, a strain calibration unit and an electronic switching unit. These units can be adapted to other systems.

A Dynamic Strain Calibrator

By MORRIS HALIO
Ballistic Research Labs.
Aberdeen Proving Ground
Maryland

THE dynamic strain calibrator described here was designed by the author to fit into an existing recording system in use at the Ballistic Research Laboratories. This system is employed for obtaining fundamental data which is ultimately used in the design of ordnance equipment such as guns, rockets, mortars, missiles, etc. The output of various types of transducers are recorded as oscillograms on moving film. The existing circuitry permits use with piezoelectric and resistance type gages, although the equipment is adaptable for use with other transducer types.

Fig. 1: Simplified diagram shows complete recording system



Piezoelectric gages incorporate, as an active element, material such as quartz, tourmaline or barium titanate and measure fluid pressure such as that produced in a chamber by an explosive or the air blast in the path of a detonation wave. Resistance type gages can measure quantities, such as strain and temperature, which are capable of varying resistivity of these transducers.

Except for frequency standards, the electronic components of the recording system are of laboratory design and construction, the major portion of the design work having been performed by Mr. Ralph E. A. Putnam of the Ballistic Research Laboratories.

Four channels of cathode-ray recording are provided for, the oscillogram being obtained on a 35mm moving film camera (Fig. 1). The heart of the system consists of the dc amplifiers which have been designed for extremely high stability and employ generous amounts of inverse feedback. Dc amplifiers are a must since many phenomena which are recorded contain a large percentage of low frequency components.

A 35mm type 651-AH General Radio camera permits a maximum speed of 2 inches per millisecond. Each trace has impressed on it a series of spikes at selectable frequencies from 50 to 1000 CPS depending upon the camera speed. These are derived from a

* Since writing this article, Mr. Morris Halio has changed positions. He is now employed by the office of Operations Analysis, Headquarters Air Defense Command, Colorado Springs, Colorado, and is serving as Chief Operations Analyst, F-106 Joint Test Force, McGuire Air Force Base, New Jersey.

frequency standard which drives a shaping circuit whose output is fed to the CRT.

Since time is an extremely important parameter in the measurement of these phenomena, possible frequency shift is insured against by employing additional frequency standards as a check. Through suitable circuits these operate timing lamps (R-1130B facsimile lamps are used) whose light output is recorded near each edge of the film. These appear as dark dots or dashes, depending on the wave-forming circuit employed, and also simplify reading of the time scale.

Pulse Markers

It is often necessary to coorelate the time of occurrence of some event with the variation in the parameter being measured. A fiducial marker circuit helps provide this information. For instance, when obtaining an oscillogram of gas pressure in a gun chamber versus time, it is desirable to indicate the time at which the projectile reaches the muzzle. The projectile can be made either to open or close a circuit whose output is fed to the fiducial marker circuit, then to the dc amplifier, producing a spike on the trace opposite in direction to the timing markers.

The recorder is also used to measure projectile velocity. Projectiles are magnetized before firing, and a pair of solenoids are placed a known distance apart along the trajectory. The induced voltage is fed to wave shapers, then to the amplifier input. A different type of pulse is used to distinguish the velocity coil indications from other markers on the oscillogram.

A piezoelectric circuit converts the electrostatic charge generated by a piezoelectric pickup into a voltage which is fed into the dc amplifier. This circuit includes a ballast section, consisting of a bank of capacitors whose purpose is to vary the sensitivity of the pickup assembly as well as a charge calibrator. The latter makes it possible to calibrate the recording system for oscillogram deflection vs. charge generated by the gage. A precision attenuator connected to the power supply in the charge calibrator permits use as a voltage calibrator to increase the flexibility of use of the system.

A strain circuit converts the change in resistance of a strain type transducer into an electrical signal which is transmitted to the dc amplifier. The strain calibrator which is described in this article serves to calibrate the recording system for oscillogram deflection vs. change in resistance of the gage. The calibrator consists of two parts, a strain calibration unit and an electronic switching unit.

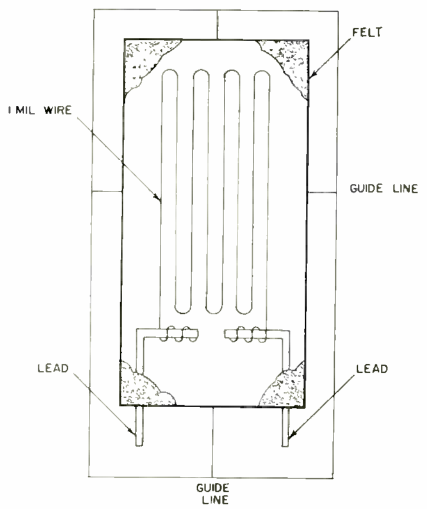


Fig. 2: A strain resistance patch gage for measuring surface strains is illustrated.

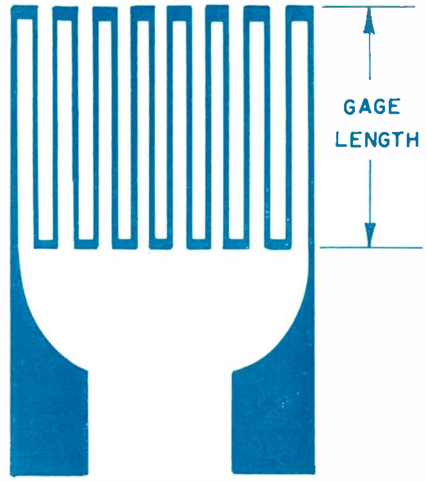


Fig. 3: This British invented strain gage element is made of foil.

An electronic sequence timer is used to control internal functions within the recording system as well as external events. The former includes cathode ray beam intensification, de-activating the sweep circuit, operating the camera, controlling the timing marker circuits, and calibrating the record. External events controlled by the sequence timer may be firing a gun, igniting a rocket, etc.

Before discussing the strain calibrator, a few words should be said about the types of transducers employed with strain circuits as well as the strain circuits themselves.

Strain Gage Wire

The operation of strain resistance gages is based on the fact that the resistance of a given piece of wire will vary as it is stretched. The strain sensitivity factor is defined (1) as

$$S_t = \frac{\frac{\delta R}{R}}{\frac{\delta L}{L}}$$

where the numerator is the relative change of resistance and the denominator the relative change in length.

If this factor were purely a function of geometry, as one might assume intuitively, it would be a constant for all materials. However, it varies with the material and can be expressed (1) as:

$$S_t = \frac{\frac{\delta R}{R}}{\frac{\delta L}{L}} = \frac{\frac{\delta \rho}{\rho}}{\frac{\delta L}{L}} + (1 + 2\mu)$$

where S_t = strain sensitivity factor
R = resistance
ρ = specific resistivity
μ = Poisson ratio
L = Length of wire

In this equation $(1 + 2\mu)$ represents the influence of dimen-

(*Continued on following page*)

Strain Calibrator *(Continued)*

sional change while $\frac{\delta R / R}{\delta L / L}$ represents change in specific resistivity with length.

If it were not for the latter, the strain sensitivity for various materials would all be approximately 1.6. However, it varies widely for different materials. Values of S_t for representative materials (1) are:

5% iridium-platinum	5.1
constantan	2.1
iso-elastic	3.6
manganin	0.47
nichrome	2.1

Strain sensitive wire may be used in various forms for gages. A popular one is the strain resistance patch gage for measuring surface strains. It is manufactured commercially in this country as the SR-4 gage by the Baldwin-Lima-Hamilton Corporation. It consists essentially of a flat winding of wire cemented to a thin sheet of paper (Fig. 2) which acts as the carrier and is in turn cemented to the surface whose strain is to be measured.

The British have recently invented a new type of strain gage in which the strain-sensitive element is composed of metallic foil. The latter is slotted (Fig. 3) alternately from each end to form a continuous grid or series of loops similar in pattern to the SR-4 strain gage, except that the conductor cross-section is rectangular instead of round. These are produced by a printing process and possess several advantages over the wire type. They lend themselves to mass production, furnish better adhesion to the supporting material, and can carry larger current to provide increased sensitivity in strain measurement.

Aside from employment in patch gages to measure surface strains, strain-sensitive wire can be attached directly to various types of transducers to measure other parameters. For example, fluid pressure can be measured by the change in resistance of a coil of wire attached to the outside surface of a tube which is expanded by the pressure.

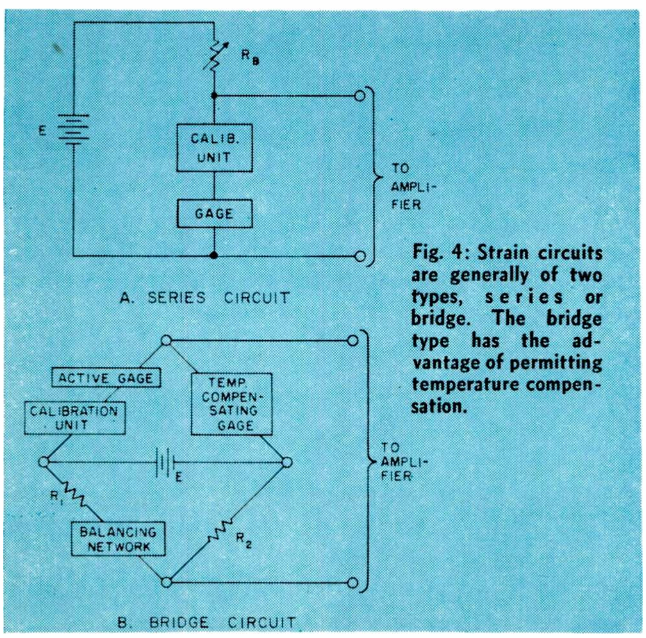


Fig. 4: Strain circuits are generally of two types, series or bridge. The bridge type has the advantage of permitting temperature compensation.

Strain Gage Circuits

Strain circuits are generally of two types, series or bridge. In the series arrangement (Fig. 4A), the power supply, strain gage and current limiting resistors are all in series, the signal being picked off the gage. Resistor R_B limits the current to a safe value for the gage. Provision is made for calibration so that a given deflection in the oscillogram will represent a known value of resistance. The bridge arrangement shown in Fig. 4B has the advantage of permitting temperature compensation. Since strain-sensitive materials are unfortunately also somewhat temperature-sensitive, temperature compensation is required for higher accuracy. A duplicate strain gage which is subjected to the same temperature as the active gage, but not any strain is attached to the adjacent arm of the bridge, thus eliminating temperature effects.

Another advantage of the bridge arrangement over the series circuit is that the large values of direct voltage superimposed on the signal in the output of the latter circuit preclude the use of dc amplifiers which are required to record very slowly varying phenomena. A dc source is used for the BRL equipment in preference to a carrier system, since it enables recording of strains from steady signal to fairly high frequencies without the complications of capacitive unbalances, radiation, etc.

The strain calibrator consists of two units, the Strain Calibration Unit and the Electronic Switching Unit which controls it. The former includes four separate channels, each of which gives 6 equal steps in 4 resistance ranges, ¼, ½, 1 and 2 ohms per step. A base line selector switch determines polarity of the calibration step. It may be set so that all steps are positive (increasing resistance), all negative, or any combination of positive or negative, there being seven possibilities in all. The precision of the intervals is 0.1%.

Strain Calibration Unit

The Strain Calibration Unit (Fig. 5) contains the calibration resistors as well as relays for switching these. Relays K_1 through K_7 are shown in the initial de-energized condition in the diagram. A set of six resistors is connected in series and each of the junctions is attached to the normally open contacts of a mercury relay so that one end of the shunting resistor R_2 can be connected to the junction, the other end being tied to the bottom of the string through K_7 relay. Mercury relays have been selected both to minimize contact resistance and decrease electrical

Strain Calibrator *(Continued)*

CAPACITORS

C_1 THRU C_9 - .0003 μfd, MICA, 500 V.

SWITCHES

S_1 - ROTARY, 8 SEC., 4 POSITION

S_2 - ROTARY, 1 SEC., 8 POSITION

CONNECTORS

J_1 - 12 POLE, MALE, AMPHENOL

J_2 - JONES RECEPTACLE, 4 POLE, MALE, 2400 SERIES

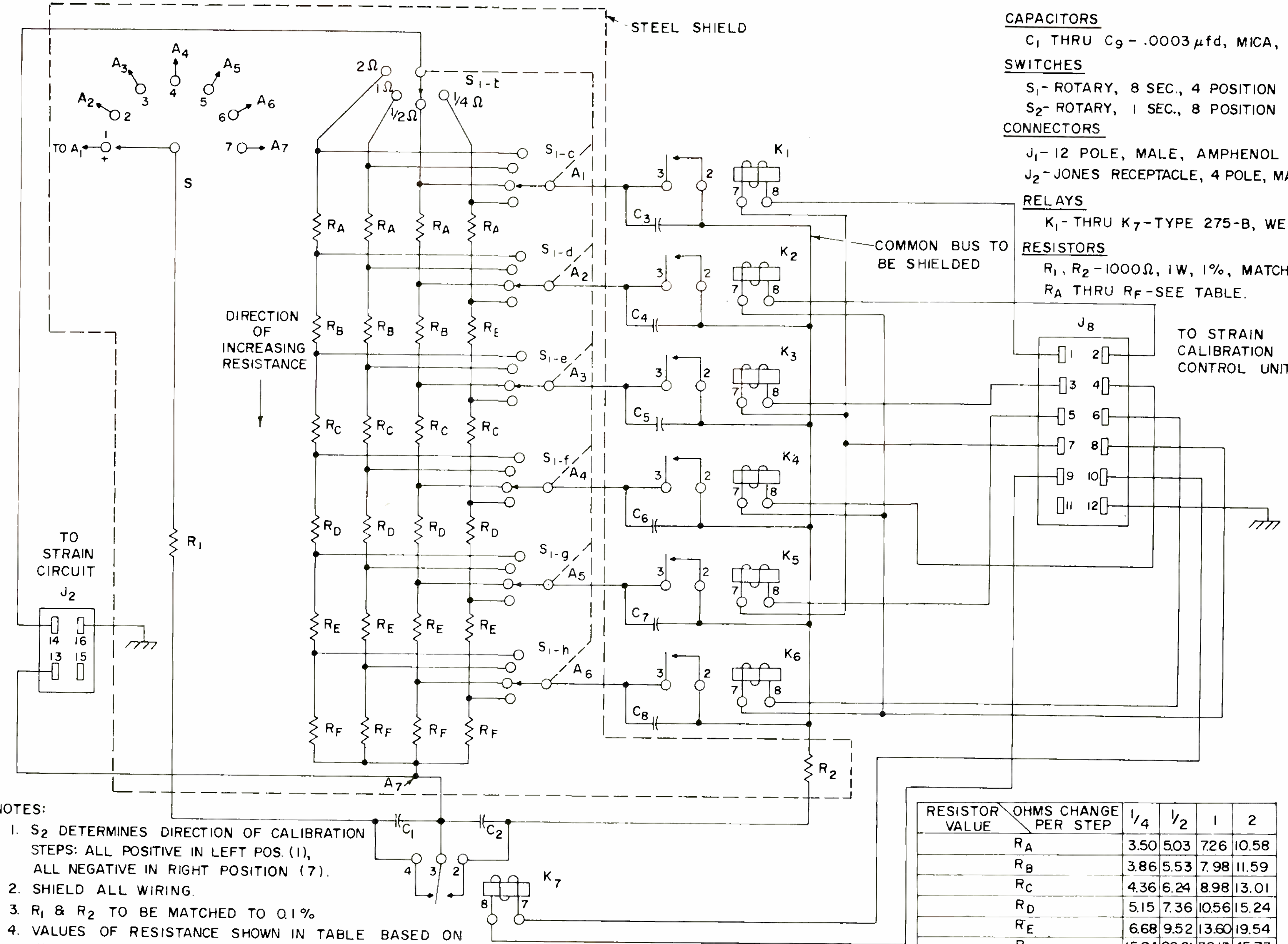
RELAYS

K_1 - THRU K_7 - TYPE 275-B, WESTERN ELECTRIC

RESISTORS

R_1, R_2 - 1000 Ω, 1 W, 1%, MATCHED TO .1%

R_A THRU R_F - SEE TABLE.



RESISTOR VALUE \ OHMS CHANGE PER STEP	1/4	1/2	1	2
R_A	3.50	5.03	7.26	10.58
R_B	3.86	5.53	7.98	11.59
R_C	4.36	6.24	8.98	13.01
R_D	5.15	7.36	10.56	15.24
R_E	6.68	9.52	13.60	19.54
R_F	15.94	22.61	32.13	45.73

Fig. 5: Schematic shows in detail the strain calibration unit

NOTES:

1. S_2 DETERMINES DIRECTION OF CALIBRATION STEPS: ALL POSITIVE IN LEFT POS. (1), ALL NEGATIVE IN RIGHT POSITION (7).
2. SHIELD ALL WIRING.
3. R_1 & R_2 TO BE MATCHED TO 0.1%
4. VALUES OF RESISTANCE SHOWN IN TABLE BASED ON VALUES, OF SHUNTING RESISTORS R_1 = R_2 = 1000 OHMS.
5. OPERATION - RELAYS K_1 TO K_6 CLOSE, THEN OPEN SUCCESSIVELY AFTER K_7 CLOSES. K_7 THEN OPENS.
6. ⏚ REPRESENTS CHASSIS GROUND.

Strain Calibrator *(Continued)*

noise which would introduce hash on to the calibration marks on the record. The resistance of the set of contacts which is in series with the 1000 ohm shunt resistor R_2 is about 30 milliohms maximum so that inaccuracy of contact resistance is eliminated and noise is much too small to be detectable.

The net resistance of the string varies from a minimum when R_2 is connected to point A_1 by relay K_1 (which closes and reopens before K_2 is energized) to a maximum when it is removed from the string. As the contact point for R_2 is moved downward, i.e., from A_1 towards A_6 the net resistance between minimum and maximum values is constant. However, the magnitude of positive and negative excursions (positive being an increase, negative a decrease) relative to the value before or after the calibration process—this level is usually called the "baseline"—is controlled in the following manner. A second 1000 ohm resistor R_1, which is matched to within 0.1% of R_2 is normally connected by switch S_2 to one of the positions A_1 through A_7. When it is set at A_1, the net resistance is a minimum, so that the calibration steps are entirely in the positive direction. When it is set at A_7, it is out of the circuit and the net resistance of the string is a maximum before relay K_7 is energized, so that the calibration steps are completely in the negative direction. By positioning the switch at A_2 through A_6, various combinations of positive and negative steps can be obtained. The method for calculating the required resistor values is given in the Appendix.

Electronic Switching Unit

The Electronic Switching Unit, Fig. 6, consists of a cascade of six monostable multivibrators (V_1 through V_6) which operate the four paralleled mercury relays K_1 through K_6 in the four-channel Strain Calibration Unit in succession. Since each multivibrator controls four relays in parallel (four K_1's, four K_2's, etc.), a power stage is required; therefore, each multivibrator drives a 6AQ5 tube (V_7 through V_{12}) which operates as a cathode follower with the relays as the cathode load.

The multivibrator is a positive grid return type as shown in Fig. 6. The first half of V_1 is normally conducting since its grid (pin 2) is positive. Triggering is performed either by a panel switch or remotely by a sequence timer relay contact. This impresses a positive pulse on the cathodes of the first tube V_1 so that the grid-to-cathode voltage of the first half of the tube is driven negatively, thus decreasing current flow in this portion. The consequent rise in voltage of the first plate is transmitted to the second grid (pin 7), thus causing this triode to conduct. The potential of the second plate begins to decrease, this drop-in voltage being impressed on the first grid, producing further decrease of current in this section. This action continues until the first half of the tube is cut off and the second half is fully conducting.

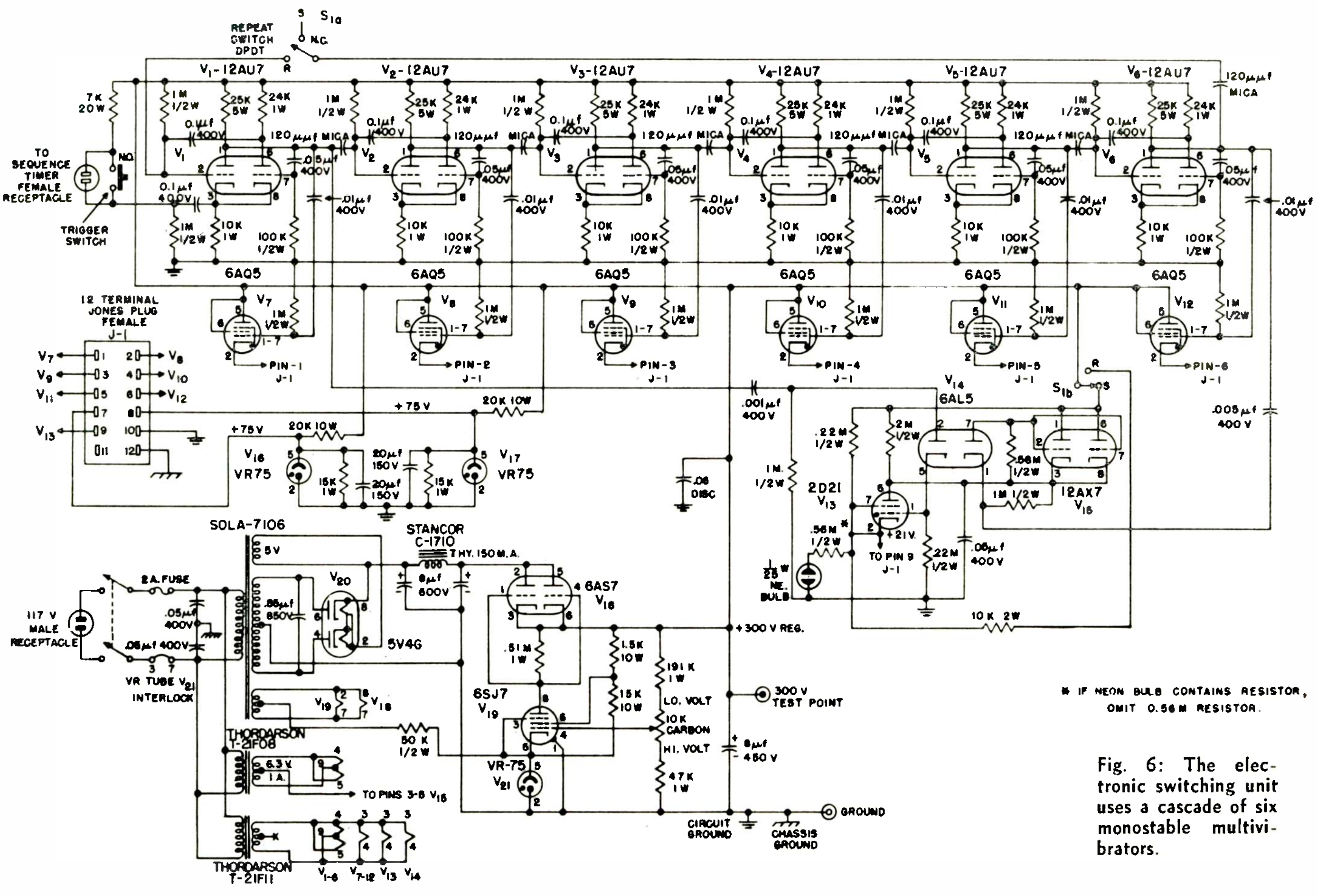


Fig. 6: The electronic switching unit uses a cascade of six monostable multivibrators.

This condition persists until the 0.1 microfarad capacitor connected to pin 6 charges-up through the one megohm resistor and the second half of the tube impresses on the first grid, a potential sufficient to cause it to start conducting. This produces a drop in voltage on the first plate which is transmitted to the second grid, decreasing current in this triode. The potential of the second plate rises, driving the first grid more positive and increasing current flow in this portion of the tube. This action continues until the steady state is reached, where the first half is conducting, while the second half is cut off.

Each multivibrator stage is triggered by the preceding one. The positive rectangular pulse from plate, pin 1 of the first tube is differentiated by a resistance-capacitance network before being impressed on the grid, pin 2, of the following stage (V_2). The positive pulse has no effect since the first half of stage number two is already conducting, but the negative pulse triggers this stage, (V_2), producing the same action as was described in the first stage. Each stage is operated in turn and the sequence stops at the last stage. This is the non-repetitive method of operation used when taking a record.

The positive rectangular pulse from the first plate of the multivibrator is differentiated before it is applied to the grid of the 6AQ5. The differentiator time constant has been adjusted so that the decay time of the voltage wave at the cathode will be of the proper value. This will result in a relay operating time giving the desired spacing between calibration steps on the calibration record.

For proper timing of the duration of the calibration, it is necessary to synchronize the base line selector relay K_7 with the multivibrators. The K_7 relays must be energized during the multivibrator cycle. This is accomplished by means of an electronic synchronizing circuit (Fig. 7).

The positive rectangular waveform from the first plate of the first multivibrator is differentiated, clipped by diode V_{14A} and the resulting positive pulse ignites thyratron V_{13} which actuates the K_7 relays in the Strain Calibration Unit. Since high current operation of thyratrons and reliable extinguishing characteristics are irreconcilable requirements by conventional methods, a unique circuit was designed for the purpose. A triode, V_{15}, in the thyratron plate circuit, V_{13} (Fig. 7), acts as a fast operating switch, conducting current to actuate the relays but presenting a high impedance path when extinction of the 2D21 tube is desired. The triode operates at zero bias so that it will conduct at the instant the thyratron receives a positive trigger.

V_{15} remains in this condition until it receives a negative pulse at the end of the calibration time from V_6. This is accomplished by differentiating the pulse from the first plate of the last multivibrator stage, clipping the positive peak through diode $V_{14\text{-}B}$, and driving V_{15} below cutoff with the resulting negative pulse. Thus the tube conductance which shunts the two megohm thyratron plate resistor is removed, so that rapid and reliable extinction is achieved.

Just before taking a strain record, it is advisable to view the calibration marks on the CRT. This is useful not only in adjusting the amplifier gains properly, but serves as a monitor on the overall operation of the system. For this purpose, the multivibrators are arranged to operate as a continuous ring by means of repeat switch S_1. (See Fig. 6). When the latter is in repeat position, section S_{1A} connects the output of the last multivibrator (V_6) back to the input of the first stage (V_1) so that it will be retriggered after each cycle. In addition, section S_1B disables the calibration synchronizing circuit V_{13}, V_{14} and V_{15}.

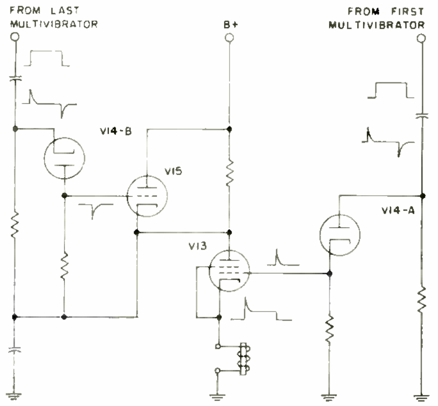


Fig. 7 (above): Simplified diagram of the calibration schematic circuit is shown

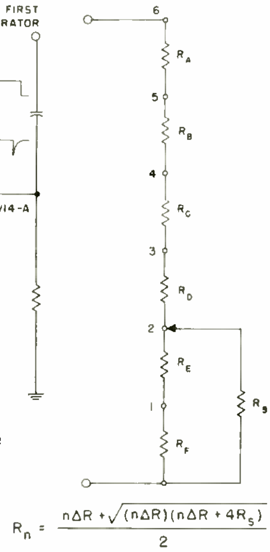


Fig. 8 (left): Calibration resistor calculations are illustrated graphically

Appendix

The values of calibration resistors employed are a function of step size, step number and magnitude of shunting resistor R_S. First the total resistance R_n between the tap and the bottom of the string (Fig. 8) which is shunted by R_S is calculated for each step number from the formula:

$$R_n = \frac{n\,\Delta R + \sqrt{n\,\Delta R\,(n\,\Delta R + 4R_S)}}{2}$$

where n = step number

ΔR = step size in ohms

R_S = value of shunting resistor

Then the individual resistor values are determined, beginning at the bottom end of the string. Thus, $R_F = R_1$, $R_E = R_2 - R_1$, $R_D = R_3 - R_2$, etc. Table 1 shows the derivation of values for ΔR = 2 ohms as an example.

TABLE 1

Calibration Resistor Values

n	n ΔR	R_n	Calibration Resistor
1	2	45.73	$R_F = R_1 = 45.73$
2	4	65.27	$R_E = R_2 - R_1 = 19.54$
3	6	80.51	$R_D = R_3 - R_2 = 15.24$
4	8	93.52	$R_C = R_4 - R_3 = 13.01$
5	10	105.11	$R_B = R_5 - R_4 = 11.59$
6	12	115.69	$R_A = R_6 - R_5 = 10.58$

References

1. Murray, William M., and Stein, Peter K., *Strain Gage Techniques*, Massachusetts Institute of Technology, Cambridge, Mass., 1957.

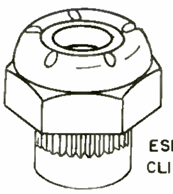
Electronic Hardware—

Screws, Washers, & Retaining Rings

This is the third in a series which describes hardware for the electronic industry. Part three presents, in tabular form, a complete description of threaded studs, washers, retaining rings, machine screws, sealing screws, tapping screws, cap screws, headless set screws, self-locking screws and more on clinch nuts. Each item is clearly described and illustrated along uses, types of material they are made of, size ranges, and known suppliers.

By L. H. HENSCHEL
Mechanical Standards Engineer
Radio Corp. of America
Camden 2, N. J.

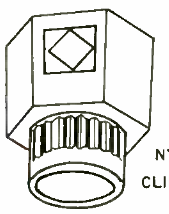
CLINCH NUTS



ESNA CLINCH NUT

The ESNA self-locking clinch nut is designed to be inserted in a hole which is slightly less than the knurled portion of the nut. After the nut is installed it is flared into the panel. Several varieties are available, with some resulting in an entirely flush installation and some leaving a roll over on the underside of the panel. The locking of the internal thread is done by means of the standard ESNA nylon disc.

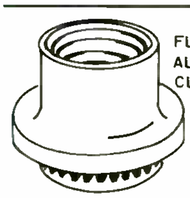
Sizes: #4 to 5/16 inch
Material: Steel, aluminum, brass.
Known supplier: Elastic Stop Nut Corp. of America, Union, N. J.



NYLOCK CLINCH NUT

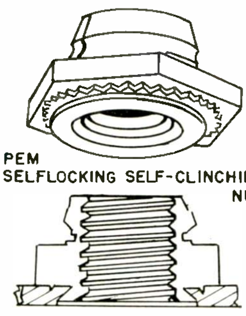
The Nylok clinch nut has a hexagonal head with a cylindrical shank which is knurled near the head. It fits into a slightly undersized hole and is rolled or flared into the parent metal. The knurl prevents the nut from turning within the sheet. The internal locking feature is the nylon plug which is located in one of the sides of the hex. Minimum sheet thickness is 0.033 in.

Sizes: #4 to 5/16 inch
Material: Steel, stainless steel, aluminum, brass
Known supplier: Nylok Corp., Paramus, N. J.



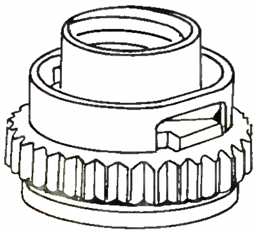
FLUSH ALL METAL CLINCH NUT

The flush, all-metal clinch nut is placed so that the knurled section is located in the panel hole. Next, it is flared into the panel by a cone shaped tool installed in a normal press. As pressure is applied the thin wall of the knurled section is flared into the metal, captivating the nut. The internal locking action is supplied bv the deformation of the upper threads of the nut. Two shank lengths are available.
Sizes: #2 to ¼ inch
Material: Steel—heat treated, stainless steel
Known suppliers: Kaynar Mfg. Co. Inc., Los Angeles, Calif.; Elastic Stop Nut Corp. Of America, Union, N. J.



PEM SELFLOCKING SELF-CLINCHING NUT

The Pem Self-Locking Self-Clinching nut requires nothing but a standard press for installation. The serrated, undercut pilot portion acts as the captivating and anti-torque feature. The nuts can be used in sheets as thin as 0.040 in. although there are two pilot sizes, the other being for panels over 0.054 in. The nut is just pressed into a drilled or punched hole in aluminum, brass, or cold rolled steel. The locking feature is developed on the deflected beam principle with the two halves of the nut deflecting as the screw enters.
Sizes: #4 to 10
Material: Steel, stainless steel (303), aluminum
Known supplier: Penn Engineering and Manufacturing Corp., Doylestown, Pa.



ROSAN FLOATING PRESS NUT

The floating press nut combines the advantages of the self-clinching Press Nut and the floating anchor nut. While the nut is merely pressed into the panel it has 0.030 in. float in all directions. Minimum sheet thickness is 0.045 in.

Sizes: #4 to ½ inch

Material: Steel

Known supplier: Rosan Inc., Newport Beach, Calif.

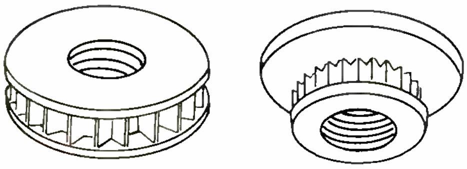
PERMA-LOCK INSERT

The Perma-Lock insert is pressed into the provided hole until the head section meets the panel. As the screw is inserted it expands the split section, causing the nut to become captive. Minimum panel thickness is 0.020 in. This device can be used to attach several sheets together. The knurled section serves to stop the assembly from turning within the sheet. They can be used in most all meterials.

Sizes: #4 to 9/16 inch

Material: Steel, brass, aluminum.

Known supplier: J. B. Plevyak Mfg. Co., Newton, N. J.



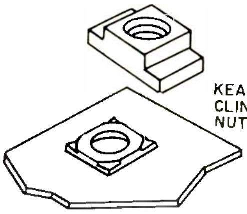
MY-T-GRIP

The My-T-Grip Fastener is cylindrical in shape with an undercut section that is knurled and acts as the anti-torque and captivating features. After insertion in the hole, this fastener must be staked in place so that the parent metal can flow into the undercut. Nine sizes are available to accommodate sheet thicknesses from 0.031 to 0.250 in.

Sizes: #2 to 10

Material: Stainless steel (303), steel

Known supplier: My-T-Grip Mfg. Co. Inc., New York, N. Y.



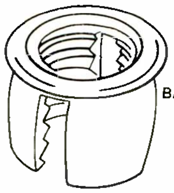
KEAN CLINCH NUT

The Kean clinch nut is installed in a pre-cut square hole or can pierce its own hole during installation. After installation into the panel, it is staked by a special tool. This nut is very useful, for high production work as tools are available for very rapid insertion.

Sizes: #6 to ⅜ inch

Material: Steel

Known supplier: Kean Mfg. Co., Dearborn, Mich.



BANC-LOC

The Banc-loc Tapped Hole is pushed into a hole in the panel and as the screw is installed, it spreads the two halves of the nut, captivating the sheet in the groove in the nut. Inward pressure of the nut locks the screw.

Sizes: #4 to ¼ inch

Material: Aluminum, brass, steel, stainless steel

Known supplier: Boots Aircraft Nut Corp., Norwalk, Conn.

MACHINE SCREWS (ASA-B18.6)

Because screws are easily installed and removed and because they can be used in blind holes as well as with nuts, they are the most generally used fastener. The electronics industry uses machine screws rather than bolts because of their wide range of diameters, head styles and lengths. Machine screws have their entire length threaded in the case of those two inches long and shorter, and the longer sizes have a minimum thread length of 1¾ inches. The diameter of the unthreaded portion is never greater than the nominal or maximum thread diameter.

Machine screws have eight basic head configurations with the flat head having 2 separate countersink dimensions. The table below compares the dimensions of the standard heads and enables the correct styles to be chosen for each application. All screws are available in slotted or cross recessed heads and in a variety of materials including brass, steel, aluminum, stainless steel and some plastics.

ROUND

Round head. This style is a standard for machine screws and tapping screws as well as for cap screws and wood screws and has been the most commonly used design in commercial work both in and out of the electronics industry, but is gradually giving way to the pan head.

FLAT

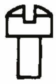
Flat head 82°. This style is used where protrusion of the head is not allowable and where a flush finished surface is desired. The panel thickness should be 1½ times the head height in order to obtain maximum strength.

Flat head 100°. This style is used for the same application as the 82° screw but where the screw is installed in thinner panel or in soft material where a larger bearing surface is desired.

MACHINE SCREWS (ASA-B18.6) Continued


OVAL

Oval head. This type is largely used where a decorative finish is desired and yet a countersunk head is required. The dimensions of the countersink are the same as those for the 82° flat head screw but the rounded part protrudes above the panel.


FILLISTER

Fillister head. This style has a rounded head with cylindrical sides and a flat bearing surface. It is used where a small head diameter is required or when the screw is to be installed in a counterbored hole. This screw is available with the regular slotted head, cross recessed head and a slotted head with a hole drilled through it at 90° to the slot so lock wiring can be used.


TRUSS

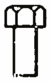
Truss head. This style has a low rounded head of larger diameter than the round head screw giving it an increased bearing surface. It is used where the low head is required and where the large bearing surface is needed to cover oversized holes, etc.


BINDING

Binding head. This style has a rounded top with tapered sides which allows for a large bearing surface and small head top. The bearing surface is often undercut. This head style is made only on machine screws. Although this style used to be very popular in electronic equipment design, it is quickly being replaced by the pan head.


SLOTTED PAN

Pan head. This style is most universally used in military electronics and is quickly gaining popularity in the commercial electronics field as it gives a neat appearance, low silhouette and a head diameter sufficient to take the screw load. The slotted variety has a flat top with rounded corners while the cross recess screws have a rounded top.


HEXAGON

Hex head. This style offers the advantage of a flat top and sides which will accommodate several types of wrenches. It is available with and without screw driver slots. The slotted type can be installed and removed with either a wrench or screw driver which is advantageous to service men.

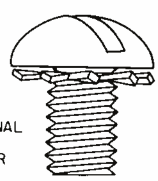
Head Dimensions of Machine Screws

	#0 (.060)		#2 (.086)		#4 (.112)		#6 (.138)		#8 (.164)		#10 (.190)		¼" (.250)	
	Dia.	Ht.	Dia.	Ht.	Dia.	Ht.	Dia.	Ht.	Dia.	Ht.	Dia.	Ht.	Dia.	Ht.
Round	.113	.053	.162	.069	.211	.086	.260	.103	.309	.120	.359	.137	.472	.175
Flat (82°)	.119	.035	.172	.051	.225	.067	.279	.083	.332	.100	.385	.116	.507	.153
Flat (100°)	—	—	—	—	.225	.048	.279	.060	.332	.072	.385	.083	.507	.110
Oval	.119	.056	.172	.080	.225	.104	.279	.128	.332	.152	.385	.176	.507	.232
Fillister	.096	.059	.140	.083	.183	.107	.226	.132	.270	.156	.313	.180	.414	.237
Truss	—	—	.194	.053	.257	.069	.321	.086	.384	.102	.448	.118	.573	.150
Binding	—	—	.181	.046	.235	.063	.290	.080	.344	.097	.399	.114	.513	.153
Pan	—	—	.167	.053	.219	.068	.270	.082	.322	.096	.373	.110	.492	.144
Cross Recessed	—	—	.167	.062	.219	.080	.270	.097	.322	.115	.373	.133	.492	.175
Hex	—	—	.145	.050	.217	.060	.287	.080	.287	.110	.361	.120	.433	.190

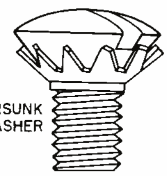
* In the case of the Hex Head machine screw the head diameter is actually the across corners dimension.

COMBINATION MACHINE SCREWS

WITH EXTERNAL LOCK WASHER



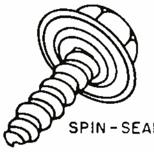
WITH COUNTERSUNK LOCK WASHER



Combination screw—lock washer assemblies are available from many sources and in many combinations. ASA B27.1 standardizes on pan head, fillister head, truss head, round head, and hexagon head machine screws with either helical lock washers or internal tooth lock washers, and flat, oval, pan, truss, round, and hexagon head screw with external tooth lock washers.

Sizes—#2 to ⅜ in.
Materials—Various

SEALING SCREWS


SPIN-SEAL

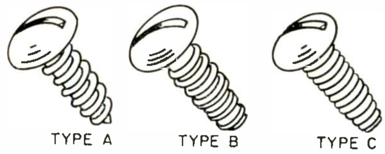
Spin-Seal screws are preassemblied screws with washers and sealant. The dome type washer retains the plastic sealant and as the screw is tightened, the sealant flows around the screw threads, between the washer and the screw and between the washer and the work. They can be used on curved or irregular surfaces as well as on flat surfaces.

Sizes—#6 to ½ in. and in many types of screw, washer and head combinations.

Materials—Steel and stainless steel.

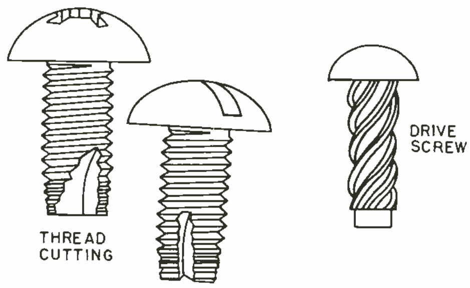
Known supplier—Russell, Burdsall and Ward Bolt and Nut Co., Port Chester, N. Y.

TAPPING SCREWS (ASA-B18.6.4)



Tapping screws are divided into two general categories, those which form the threads as they are installed (thread forming), and those which cut a thread, thread cutting). Both varieties are available with the same head configurations as the machine screws with the exception of the binding head.

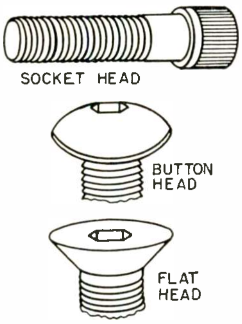
Thread forming screws are usually used in relatively soft wrought material where removal and replacement of the screw is expected to be a minimum. Thread forming screws have 3 basic types, ASA type A for light sheet metal, type B for both light and heavy sheet metal, non-ferrous castings and plastics, and type C for use in harder material where a machine screw thread is desired and where chips cannot be tolerated. It must be realized that a high driving torque is required for type C.



Thread cutting screws are divided into 2 main groups. The first, including ASA types F, G, D, and T, has threads similar to machine screws and blunt points with several cutting edges. These are used in most cast materials, sheet materials and plastics. The second group includes types BF, BG, and BT and have courser threads for use primarily in plastics and die castings.

The metallic drive screw is a form of thread forming screw with a multiple thread and large helix angle. The screws are forced into the work and usually used as a permanent fastening. They come in diameters from #0 to 3/8 in. with lengths varying from 1/8 to 1 in. The end or pilot section of the screw is unthreaded and has a reduced diameter to facilitate entrance into the work.

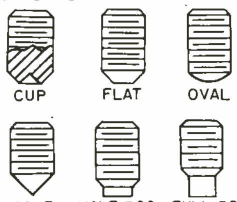
CAP SCREWS



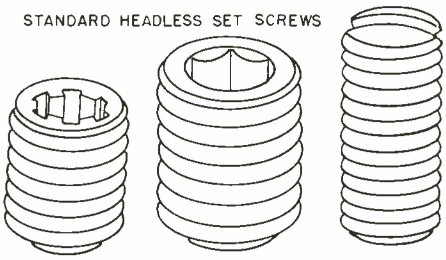
Cap screws are high strength fasteners and, in the smaller sizes, have 3 general head designs, the socket head, button head, and flat head. The socket head (ASA B18.3) is by far the most popular and has thread diameters ranging from #0 to 1½ in. It is available with both the hexagonal socket or fluted socket. The internal socket eliminates the need for wrench clearance and saves space. These screws are often mounted in counterbored holes. The button head and flat head variety require the use of an internal wrench also and are excellent high strength fasteners. Class 3A threads are standard.

SIZES	0	2	4	6	8	10	250
Max. Dia.	0.060	0.086	0.112	0.138	0.164	0.190	0.250
Head Dia.	0.096	0.140	0.183	0.226	0.270	0.312	0.375
Head Height	0.060	0.086	0.112	0.138	0.164	0.190	0.250

HEADLESS SET SCREWS

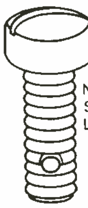


Set screws come with a variety of point designs as shown but the cup point is the most popular as it digs into the work and holds it firmly. These screws are used to fasten gears to shafts, spacers, collars, and knobs, and to prevent relative movement between parts. Screws should be installed in pairs and located at an angle of 90° or 120° with at least one point bearing on a flattened portion of the shaft. Socket head screws, both hex and fluted, are available from size #0 to 2 in. diameter and are made of high strength steel with a class 3A thread per ASA B18.3, while the same screws with a slotted head are available in sizes from #5 to ¾ in. with a case hardened surface and class 2A thread (ASA 18.6.2.).



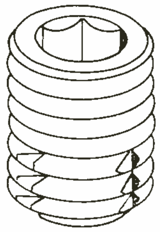
The cup point and flat point require no shaft preparation other than a flat while the other styles require deforming the shaft to accommodate the screw point. The flat point is usually used against hard materials and cup point against materials which are softer than the set screw so that it can dig in. Standard set screws are positively held in place during severe vibration by means of a sealing compound or by installing one set screw on top of the other.

SELF-LOCKING SCREWS



Self locking set screws are available in sizes from #0 to 1 in. and are made from the standard set screws above. The locking is obtained by the insertion of a nylon pellet in the screw which holds the screw securely against its mating thread. Known supplier—Nylok Corp., Paramus, N. J., or Licensee.

SET SCREWS

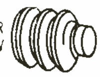


SELF-TAPPING SET SCREW

Self tapping set screws can be supplied with slot, hexagon socket or fluted socket and with any of the standard points. They eliminate tapping and firmly lock themselves in place. They are not recommended for use where the entire set screw is expected to be removed and replaced. Where the screw is merely to be loosened and retightened they are satisfactory.

Sizes—#2 to 3/8 in.

Known supplier—Set Screw Mfg. Co., Bartlett, Ill.



NO-MAR SET SCREW

W-POINT SOCKET SET SCREW

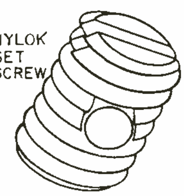
No-mar Set screws are the same as conventional slotted set screws but have a nylon point inserted in them. This point allows the set screw to hold firmly in position and yet not mar the shaft surface. The set screw material is stainless steel and the insert nylon.

Sizes—#2 to #6.

Known supplier—PIC Design Corp., East Rockaway, N. Y.

W-point socket set screws were developed to prevent walking of the set screw on the shaft by pinpointing the center prior to the cup point principle coming into play.

Known supplier—Parker Kalon, Clifton, N. J.



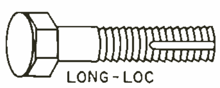
NYLOK SET SCREW

Nylok self-locking screws eliminate the need for lock washers because the nylon plug forces the mating threads into close contact giving positive locking. The plug always springs back to its original shape and regains its locking characteristics, hence the screw is reusable. Any type standard head is available, with the screws made in both aircraft and commercial grades. Tapped holes are required to be countersunk a small amount to prevent cutting of the nylon on entrance. Clearance hole should be 0.010 to 0.015 in. oversize to permit proper clearance of the plug. Locking device meets requirements of Mil-F-18240.

Materials—Steel, stainless steel, brass, bronze, aluminum.

Sizes—#0 to 1 in.

Known supplier—Nylok Corp., Paramus, N. J.



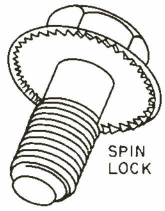
LONG-LOC

Long-Lok screws are similar to the Nylok screws above except that the insert is along the axis of the screw rather than a plug. The locking element is available in many materials depending on the temperature requirement with Nylon and Kel-F being the most popular. The installation hole should be countersunk as above and the clearance hole enlarged. Locking device meets Mil-F-18340. These make excellent adjusting screws. Available in many head styles.

Material—Steel, aluminum, brass, stainless steel.

Sizes—#0 to 2 in.

Known supplier—Long-Lok Corp., Santa Monica, Calif.

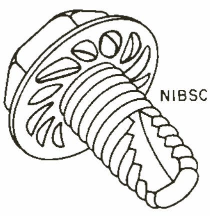


SPIN LOCK

Spin Lock screws have a toothed washer face on the bearing surface in order to firmly lock them in position. Because of this design, they require approximately 20% more torque to remove them than to install them. They are available with flat heads as well the hex head.

Sizes—#2 to 1/2 in.

Known supplier—Russell Burdsal and Ward Bolt and Nut Co., Port Chester, N. Y.



NIBSCREW

Nibscrews are self-tapping, self-locking screws. After the screw is properly seated the "Nib" takes up the torque and holds the assembly firmly. They are available in washer faced hex head, truss head, and pan head.

Sizes—#6 to 1/4 in.

Materials—Stainless steel, aluminum, steel.

Known supplier—Shakeproof, Elgin, Ill.

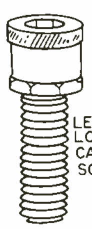
"WHIZ-LOCK"

The "Whiz-Lock" screw is a free spinning reusable self-locking screw which locks in position when its bearing surface, having teeth, meets the surface of the material being fastened.

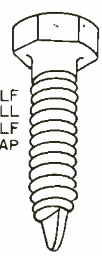
Sizes—#6 to 3/8 in. hex head and washer head.

Material—Steel.

Known supplier—MacLean-Fogg Lock Nut Co., Chicago, Ill.



LED-LOK CAP SCREW



SELF DRILL SELF TAP

Led-Lock Cap screws have a specially designed lead washer under its specially designed head. As the screw is tightened the washer extrudes to create a seal around the threads and the head. They are excellent for use in counterbored holes. They are vibration resistant and can be reused by attaching a new head washer.

Sizes—#4 to 1 1/2 in.

Material—Alloy steel.

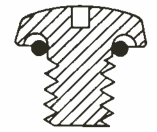
Known supplier—Safety Socket Screw Co., Chicago, Ill.

The Self Drill self-tap screws have the advantage of eliminating drilling and tapping operations. The screws can be installed either manually or with power tools in plastics and metals.

Sizes—#6 to 3/8 in.

Materials—Steel.

Known supplier—Eaton Mfg. Co., Massillon, Ohio.



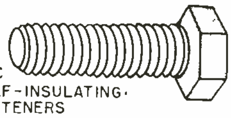
SEELSCREW

Seelscrews are specially designed machine screws with a silicon rubber "O" ring seated under the head. The "O" ring deforms as the screw is tightened and fills the void between the screw and the assembly creating a seal against the escape or access of liquid or gas. The "O" material can seal pressures as high as 500 PSI and can be used over a temperature range of —120°F to +500°F. The clearance hole is critical when using these screws.

Sizes—#4 to 1/4 in.

Materials—Screws—Stainless steel, brass, aluminum and steel—limited availability.

Known supplier—Automatic & Precision Mfg. Co., Yonkers, N. Y.



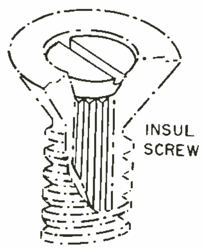
GRC SELF-INSULATING FASTENERS

GRC Self-insulating fasteners are also self sealing. A plastic head covers the metal stud. The plastic seals as the screw is tightened.

Sizes—All standard screws.

Materials—screws—brass, steel and stainless steel.

Known supplier—Gries Reproducer Corp., New Rochelle, N. Y.



INSUL SCREW

The Insul-screw is a nylon screw with a metal core. This metal core increases the shear strength of the screw over a straight plastic screw while the plastic gives the insulation properties and anti-corrosive properties.

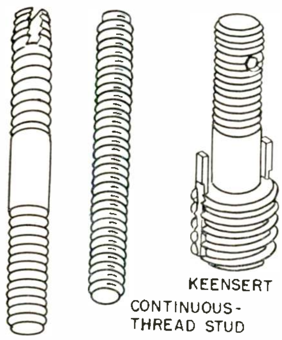
Sizes—#6 to 1/4 in.

Head styles—Fillister, round, washer, slotted and cross recessed.

Material—Zytel 101 with cores of steel, brass, aluminum and stainless steel.

Known supplier—Austin Screw Co., Chicago, Ill.

THREADED STUDS



KEENSERT

CONTINUOUS-THREAD STUD

SELF-TAPPING STUD

The most familiar threaded stud for small thread sizes is the continuous thread stud which has thread for its entire length and is chamfered on both ends. These studs can be obtained from any specialty house in various materials and thread sizes, or cut from longer lengths.

The self-tapping stud has the advantage over the continuous stud that it can be installed directly into a drilled or cored hole. It also locks itself into position because of the torque required to insert it. They can be used in cast iron, magnesium, and plastics.

Sizes: #4 to 1 in.

Material: Case hardened steel

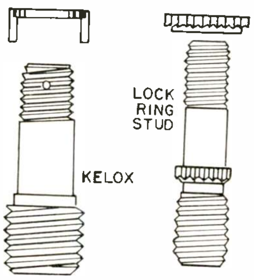
Known supplier: Pheoll Mfg. Corp., Chicago Ill.; Roson, Inc., Newport Beach, Calif.

The Keensert stud is freely installed in a pre-tapped hole and then locked in place by driving home the two pins which are preassembled to the top end of the stud. These two pins (keys) prevent the stud from rotating and coming loose. The top end is of a larger diameter than the nut end which permits it to be installed in soft materials and still have full load on the nut end. Thread class 3A.

Sizes: #8 to 1/2 in.

Materials: Stud—stainless steel, steel, aluminum Keys—303 stainless steel.

Known supplier: Newton Insert Co., Los Angeles, Calif.



LOCK RING STUD

KELOX

The Kelox stud serves the same purpose as the Keensert but is locked in position by a locking key ring which has two keys attached to it and which slides over the stud and is driven into the parent material.

Sizes: #6—1/2 in.

Material: Steel

Known supplier: Fasteners Inc., Pittsfield, Mass.

The Rosen Lock Ring Stud has the same use as the Keensert. It is locked in place by driving a serrated ring over the serrated shank of the stud and into a counterbore in the parent material.

Sizes: #6 to 3/4 in.

Material: Steel

Known supplier: Rosan Inc., Newport Beach, Calif.

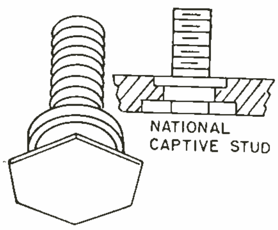
SHAKEPROOF MOUNTING SCREW

The Shakeproof Mounting Screw has two threads, a large diameter course left hand thread and a smaller diameter right hand machine screw thread. To install the screw or captivate it in the parent material, it is turned counter clockwise and the "nib" head holds it firmly. After the parts are assembled, the harder the nut is turned, the more the stud holds, and when the nut is removed the nibs hold the screw.

Sizes: #6 to #10

Material: Steel

Known supplier: Shakeproof, Elgin, Ill.



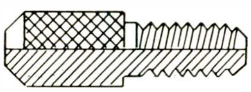
NATIONAL CAPTIVE STUD

National Captive Studs provide a permanently fixed male thread in thin sheets of aluminum, brass, and some plastics. A hole is drilled or punched a few thousandths greater in diameter than the cylindrical pilot and the stud is pressed-in until the entire hexagonal portion is imbedded in the panel. The stud is locked-in by the cold flow of metal around the barrel or undercut section. These studs are available for several material thicknesses, although those designed for the thinner panels are satisfactory in the thicker panels.

Sizes: #4 to 1/4 in.

Material: Stainless steel, Type 303

Known supplier: National Company, Malden, Mass.



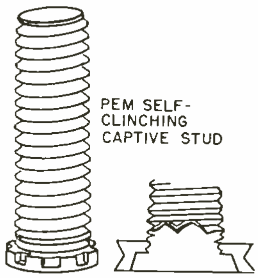
YARDLEY STUD

The Yardley Stud is a stud with one end threaded and the other knurled. It is intended for molding into plastics, some metals and ceramics.

Sizes: #4—1/4 in.

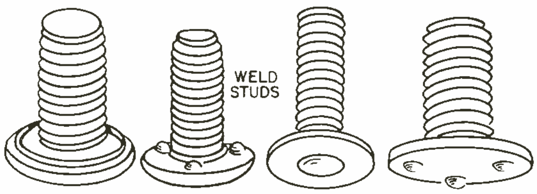
Material: Aluminum

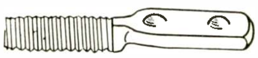
Known supplier: Yardley Precision Products Co., Yardley, Pa.

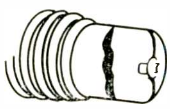


The Pem Stud has the same applications as the National stud. A hole slightly larger than the nominal thread size is drilled in the panel and the stud pressed in. The panel material cold flows into a circular portion between the threaded portion and the stud head, while the many grooves around the head act as the anti-torque device. These studs are designed to use in any material thickness from 0.040 up.

Sizes: #4 to 5/16 in.
Material: Stainless steel
Known supplier: Penn Engineering & Mfg. Co., Doylestown, Pa.







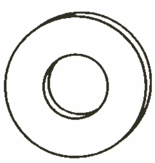
KSM WELD STUD

The use of weld studs is a convenient means of attaching male threads to their steel sheet. Projections are located on either side of the stud head making projection welding easy. The studs with projections on the thread side of the head are self-locating for they must be inserted into a hole prior to being welded.
Sizes: #4 to ⅜ in.

Materials: Unfinished steel or copper flashed steel
Known suppliers: Ohio Nut & Bolt Co., Cleveland, Ohio; Parker Kalon Co., Clifton, N. J.

The KSM weld stud is designed with an ordinary head but has a very small diameter short cylindrical projection on the center of the underside of the head. This small projection acts as the original contact for an electrical discharge which does the welding. This stud can be used in very thin panels without leaving burn marks or flash on either side of the panel. Special tools are required to install this stud.
Sizes: #10—¼ in.
Materials: Steel, stainless steel, aluminum.
Known supplier: KSM Products Inc., Merchantville, N. J.

WASHERS



FLAT WASHER

Flat Washers are available in any number of common materials including ferrous and nonferrous metals, plastics, and various fibrous materials. Washers are normally stamped but higher strength washers are available.

Flat Washer Dimensions (ASA-B-27.2)

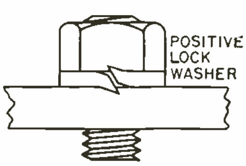
		#0	#2	#4	#6	#8	#10	¼
Size		0.060	0.086	0.112	0.138	0.164	0.190	0.250
	I. D. Min.	0.063	0.089	0.120	0.151	0.183	0.203	0.271
O. D. Max.	Small Pattern	0.130	0.193	0.255	0.318	0.380	0.411	0.505
	Regular Pattern	0.193	0.255	0.380	0.443	0.505	0.568	0.744
Thickness Max.	Small Pattern	0.028	0.028	0.036	0.036	0.045	0.045	0.071
	Regular Pattern	0.028	0.028	0.045	0.045	0.045	0.045	0.071

HELICAL SPRING TYPE

Helical spring type lock washers are the most common type used. As they are compressed they exert a tensile load on the fastening device holding it firmly against loosening. Materials include carbon steel, stainless steel (both 300 and 400 series), aluminum zinc alloy, phosphor bronze, silicon bronze and monel.

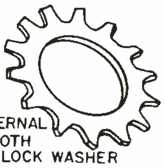
Dimensions of Helical Spring Lock Washers

		#2	#4	#6	#8	#10	¼
Size		0.86	0.112	0.138	0.164	0.190	0.250
	I. D. Min.	0.88	0.115	0.141	0.168	0.194	0.255
O. D. Max.	Light Series	0.165	0.202	0.239	0.280	0.323	0.489
	Medium Series	0.175	0.212	0.253	0.296	0.337	0.493
Thickness Max.	Light Series	0.015	0.020	0.025	0.031	0.040	0.047
	Medium Series	0.020	0.025	0.031	0.040	0.047	0.062



A variation of the spring lock washer is the positive lock washer which has two barbs that dig into the material.
Sizes: 3/16 to ¾ in.

Material: Steel
Source: Positive Lock Washer Co., Newark, N. J.

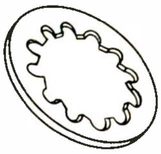


EXTERNAL TOOTH LOCK WASHER

The external tooth lock washer is very popular where electrical connections are to be made because of the "digging in" effect. Materials are similar to those available in helical type lock washers. The external tooth type has the advantage over the internal tooth type as they have a greater tooth area.

Dimensions of External Tooth Lock Washers

Size	#4	#6	#8	#10	¼
	0.112	0.138	0.164	0.190	0.250
I. D. Min.	0.115	0.141	0.168	0.195	0.256
O. D. Max.	0.260	0.320	0.381	0.410	0.475
Thickness Max.	0.019	0.022	0.023	0.025	0.028

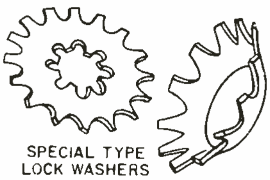


INTERNAL TOOTH LOCK WASHER

The internal tooth lock washer is often used under the head of small head style screws where the external type could be ineffective. Materials are the same as the external tooth type.

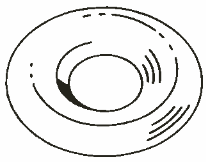
Dimensions of Internal Tooth Lock Washers

Size	#2	#4	#6	#8	#10	¼
	0.086	0.112	0.138	0.164	0.190	0.250
I. D. Min.	0.089	0.115	0.141	0.168	0.195	0.256
O. D. Max.	0.200	0.270	0.295	0.340	0.381	0.478
Thickness Max.	0.015	0.019	0.021	0.023	0.025	0.028

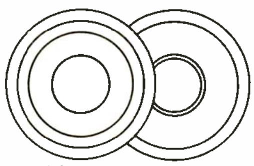


SPECIAL TYPE LOCK WASHERS

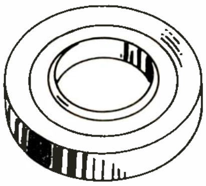
Special types of lock washers for special application include the internal—external tooth and the countersunk external tooth.



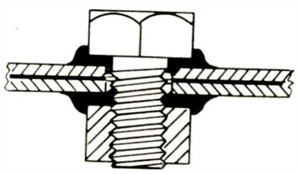
FINISHING WASHERS

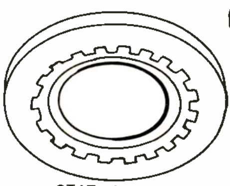


LOCK WASHERS

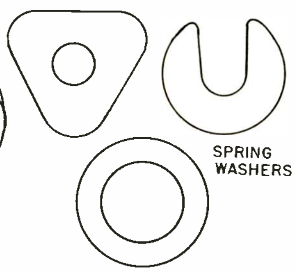


NYLON WASHER





STAT-O-SEAL



SPRING WASHERS

Finishing Washers are popular for use on the surface of finished panels as they lessen the possibility of scratched finishes.
Material: Steel, Brass, Aluminum

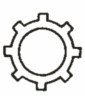
This lock washer is made of metal covered with a plastic material causing it to be both a sealing washer and a lock washer.
Size: #6—½ in.
Source: Bartite Products Corp., Everett, Mass.

The Stat-O-Seal is an 0 ring in style and is retained by a metal washer. It installs like any other plain washer but effectively seals temperature ranges from —85° to +360°F.
Size: #6 to 2 in.
Source: Parker Seal Co., Cleveland, Ohio

Manufacturers of similar sealing type washers include:
Rubber Teck, Inc., Gardena, Calif.
Franklin C. Wolfe Co., Culver City, Calif.
Illinois Tool Works, Elgin, Ill.
Precision Rubber Products Corp., Dayton, Ohio

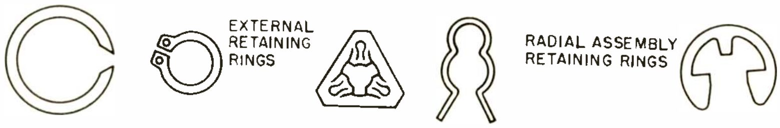
There are many varieties and styles of spring washers, however, they all have the same objective, to take up axial play. Some are axial assembled while others are asesmbled radially.

INTERNAL RETAINING RINGS



RETAINING RINGS

Internal Type Retaining Rings are available in many sizes, styles, and shapes — some requiring special tooling, others not. The internal type usually fits in the groove cut in a shaft housing, but many non-standard uses are being found for these fasteners. Some rings are bowed, while others are flat. Some are made of round stock, others from flat.



External type rings are most commonly used on shafts or studs. Some require grooving the shaft, while others are of the self-locking variety. Some are slid over the end of the shaft while others are assembled radially.

Materials: Steel, stainless steel, beryllium copper, phosphor bronze, and aluminum

Manufacturers of retaining rings are:

Waldis Kohinovr Inc., Long Island City, N. Y.
National Lock Washer Co., Newark, N. J.
Eaton Mfg. Co., Massillion, Ohio

MISCELLANEOUS TABLES

Solid Rivet Dimensions

	Max. Head Diameter					Max. Head Height				
Body Dia	Flat Hd	CSK Hd	Button Hd	Pan Hd	Truss Hd	Flat Hd	CSK Hd	Button Hd	Pan Hd	Truss Hd
1/16	0.140	0.118	0.122	0.118	—	0.027	0.027	0.052	0.040	—
3/32	0.200	0.176	0.182	0.173	0.226	0.038	0.040	0.077	0.060	0.038
1/8	0.260	0.235	0.235	0.225	0.297	0.048	0.053	0.100	0.078	0.048
5/32	0.323	0.293	0.290	0.279	0.368	0.059	0.066	0.124	0.096	0.059
3/16	0.307	0.351	0.348	0.334	0.442	0.069	0.079	0.147	0.114	0.069
7/32	0.453	0.413	0.405	0.391	0.515	0.080	0.094	0.172	0.133	0.080
1/4	0.515	0.469	0.460	0.444	0.590	0.091	0.106	0.196	0.151	0.091

Rivet Hole Sizes

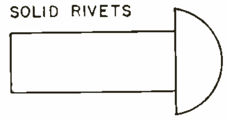
Rivet Size	Hole Size Min.	Hole Size Max.
3/32	0.093	0.096
1/8	0.128	0.134
5/32	0.160	0.167
3/16	0.191	0.199
1/4	0.255	0.264

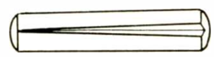
Recommended Hole Diameters for Grooved Pins

Pin Size	3/64	1/16	5/64	3/32	7/64	1/8	5/32
Hole Size Max.	0.0478	0.640	0.0798	0.0956	0.1113	0.1271	0.1587
Hole Size Min.	0.0465	0.0625	0.0781	0.0938	0.1094	0.1250	0.1563

Pin Size	3/16	7/32	1/4	5/16	3/8	7/16	1/2
Hole Size Max.	0.1903	0.2219	0.2534	0.3166	0.3797	0.4428	0.5040
Hole Size Min.	0.1875	0.2188	0.2500	0.3125	0.3750	0.4375	0.5000

SOLID RIVETS





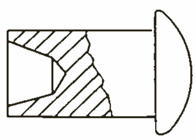
GROOVED PIN

Hole and Pin Sizes for Cotter Pins

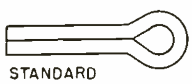
Thread or Shaft Size (in.)	Cotter Pin Size (in.)	Hole Size (in.)	Distance of Hole Center from Shaft End
1/8	1/32	3/64	3/64
3/16	3/64	1/16	5/64
1/4	1/16	5/64	7/64
5/16	5/64	3/32	7/64
3/8	3/32	7/64	9/64
7/16	3/32	7/64	11/64
1/2	1/8	7/64	11/64

Tubular Pin Installation Information

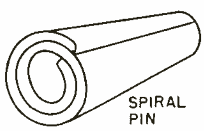
Pin Size	Hole Size Min.	Hole Size Max.	Double Shear Strength Lbs. (Steel Pins)
0.062	0.062	0.065	425
0.078	0.078	0.081	650
0.094	0.094	0.097	1000
0.125	0.125	0.129	2100
0.156	0.156	0.160	3000
0.187	0.187	0.192	4400
0.219	0.219	0.224	5700
0.250	0.250	0.256	7700
0.312	0.312	0.318	11500
0.375	0.375	0.382	17600
0.500	0.500	0.510	25800



SEMI-TUBULAR RIVET



STANDARD COTTER PIN



SPIRAL PIN

TUBULAR PIN

Hole Size & Clinch Allowance for Semi-Tubular Rivets

Rivet Dia.	Hole Dia. Min.	Clinch Allowance
1/16	0.064	0.032 – 0.038
3/32	0.093	0.046 – 0.055
0.099	0.104	0.051 – 0.061
1/8	0.128	0.064 – 0.077
9/64	0.154	0.076 – 0.092
3/16	0.199	0.098 – 0.118
7/32	0.234	0.109 – 0.141
1/4	0.265	0.130 – 0.159

Hole Size and Shear Values for Spiral Pins

Pin Dia.	Recommended Hole Size Min.	Recommended Hole Size Max.	Double Shear in Lbs. (Steel & Stainless 8A Steel Pins) Heavy Duty	Medium Duty	Light Duty
0.031	0.031	0.0325	—	75	—
0.039	0.039	0.405	—	115	—
0.047	0.047	0.485	—	170	—
0.052	0.052	0.535	—	230	—
0.062	0.062	0.065	460	300	160
0.078	0.078	0.081	720	480	260
0.094	0.094	0.097	1030	690	370
0.109	0.109	0.112	1410	940	510
0.125	0.125	0.129	1840	1230	660
0.156	0.156	0.160	2880	1920	1040
0.187	0.187	0.192	4140	2760	1500
0.219	0.219	0.224	5640	3760	2040
0.250	0.250	0.256	7360	4900	2660
0.312	0.312	0.318	11500	7670	4160
0.375	0.375	0.382	16580	11040	6000
0.437	0.437	0.345	22540	15020	8160
0.500	0.500	0.510	29440	19600	10640

H.V. FOR SATELLITES
High voltage can be produced directly from a sunbeam or other heat source by ferroelectric converter developed by ITT Labs.

Snapshots

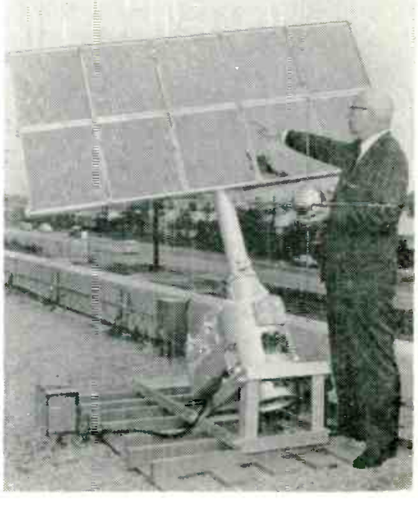
(Continued)

TUNNEL DIODE INVENTOR
Dr. Leo Esaki, center, inventor of the diode which bears his name, discusses his invention with Raytheon's Dr. Crawford Dunlap and Dr. Walter Leverton

A GIFT FROM MARS?
The music sphere represents a wholly new approach to the design of stereophonic hi-fi enclosures. It was created by Lester Beall for ALCOA and is not for sale.

LARGE RIGID RADOME
The 50 ft. by 45 ft. high radome was made by Universal Moulded Products Corp. for Marconi's Wireless Telegraph Co., Ltd. It will be used in Europe for Nato radar equipment.

SUN KEEP SHINING
"Big Bertha" contains 7,800 solar cells. It is on display at Hoffman Electronic Corp.'s new center in El Monte, Calif.



WASHINGTON

News Letter

RADIO ASTRONOMY—The nation's leading radio astronomers are urging the U. S. delegation at the International Radio Conference in Geneva to obtain an allocation of exclusive frequencies for use in radio astronomy. If adequate frequencies are not made available, they say their studies of the universe will be impossible and the large radio telescopes now being constructed will be useless. The U. S. delegation at Geneva is seeking to have the 1400-1427 megacycle "hydrogen line" as a protective band for astronomy. The radio astronomers point out that their program is most important in future space communications developments.

STRONG SUPPORT—The National Association of Railroad & Utilities Commissioners, the organization of federal and state regulatory commissions, has decided to participate in FCC hearings on the proposal for unrestricted licensing of private microwave systems. This move is regarded as strong support for the common carrier industry's request for reconsideration of its position on private microwave systems. The NARUC authorized its Special Telephone Committee to participate, for the association, in any FCC proceedings. The NARUC in a formal resolution of its executive committee emphasized that the FCC decision for the unrestricted licensing of private microwave systems could have a serious impact on the revenues of the regulated communications common carriers—the Bell System, General Telephone System, Western Union, and larger independent telephone companies.

MANUFACTURERS MICROWAVE USE — Microwave is the most important thing facing the Manufacturers radio service today. Victor G. Reis of the Bethlehem Steel Co., Chairman of the Committee on Manufacturers Radio Use, stated this at the recent annual meeting of that group in Washington. FCC Safety & Special Radio Services Bureau Chief Curtis B. Plummer said the FCC anticipates the "pooled" use of all private microwave frequencies, rather than the allocation of specific bands to various types of public safety, land transportation, industrial, and other radio uses. The "present plan" is not to establish a "separate microwave service." He also stressed that establishing an "interference-free" private microwave system will mean "a lot more engineering work" than required for a mobile radio system.

PROPAGATION REPORT — How varying the heights of transmitting and receiving antennas affects the strength of beyond-the-horizon UHF signals is described in a report by the National Bureau of Standards. The report analyzes measurements of transmission loss at 418 MC over a 134-mile path, and shows signal levels at receiving antenna heights ranging from 30 to 665 feet. The 86-page report may be ordered from the Office of Technical Services of the US Dept. of Commerce in Washington.

National Press Building *ROLAND C. DAVIES*
Washington 4

TEACHER'S AID—The National Science Foundation has awarded grants totaling $9.2 million to 33 colleges and universities to support Academic Year Institutes for science and mathematics teachers. This will be the fifth year of the program. Its purpose is to help teachers improve their subject matter knowledge through a year's advance study on a full-time basis.

CONTRACT COST REVISIONS — The issuance of revised cost principles for use in defense contracting has been announced by the Department of Defense. The new regulation provides a single comprehensive set of cost principles which will give more detailed and precise policy guidance in treating cost elements. They apply to all types of contracting or contract settlement situations. Copies of Revision No. 50 may be obtained from the Superintendent of Public Documents.

RESEARCH REPORT—The recently publicized report to the Navy which calls basic research "the life-blood of the entire system of technological innovation" and advises the Navy to do more of it has just been made available to the public through the Office of Technical Services, U. S. Department of Commerce.

The report, "Basic Research in the Navy," is based on findings of a two-year investigation of basic research effort by U. S. industry, government, and universities. It was prepared for the Naval Research Advisory Committee by Arthur D. Little, Inc. The Office of Naval Research sponsored the work. The report, PB 151925 may be ordered from OTS, U. S. Dept. of Commerce, Washington 25. It contains 189 pages in two volumes. Price $7.

A NEW ALL MOLDED OCTAL SOCKET by CINCH

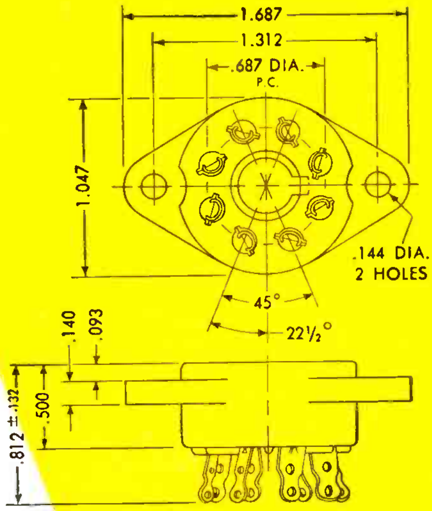
NO. 29329

NO. 29329

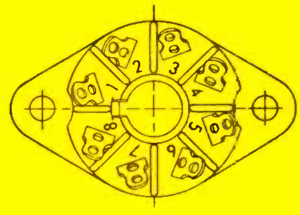
This new all molded Octal socket offers a complete one piece construction. The saddle and body are a single casting.

The standard socket is molded of general purpose Bakelite. Contacts are of brass, cadmium plated. Mica insulation with brass or phosphor bronze contacts can be made available.

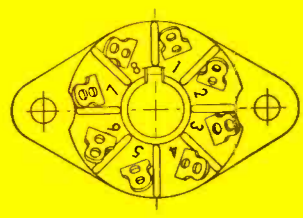
Two contact layouts can be supplied as shown below:



TYPE 1



TYPE 1



TYPE 2

Cinch ELECTRONIC COMPONENTS

CINCH MANUFACTURING COMPANY

1026 South Homan Ave., Chicago 24, Illinois

Division of United-Carr Fastener Corporation, Boston, Mass.

Centrally located plants at Chicago, Illinois, Shelbyville, Indiana, La Puente, California and St. Louis, Missouri.

Circle 50 on Inquiry Card

That Made News In 1959

Howard Brauer
Manager, Quality Control

Paul Weirich

Glen Ramsey

James H. Hall
Staff Engineer

When will our new silicon rectifier plant be in production?

By next month, the new plant will be supplementing our current silicon rectifier output by an additional 60,000 units per day. This will include our complete line of new industrial power rectifiers and the brand new silicon controlled rectifiers. The new facilities will also be used for producing our automotive silicon rectifier which, as you know, was featured in the November 15th issue of AUTOMOTIVE INDUSTRIES and the August issue of INDUSTRIAL LABORATORIES among other publications.

Are we expanding to keep up with solid tantalum capacitor demands?

Yes, we have recently completed the second phase of our S-T-A expansion program and the third phase is well under way. We are now able to deliver normal requirements from stock. Our current expansion program anticipates production requirements in 1960 approaching existing wet capacitor production. I might also mention in connection with our S-T-A, that we are actively participating in the micro-modular program.

What steps were taken to further improve product reliability?

Enlargement, consolidation and, in general, improvement of our quality control program was the latest move—another complete step in our long-range reliability plan. You know, quality control doesn't just *meet* reliability requirements . . . it *leads*.

We believe that the only purpose of quality control is to assure the reliability that is engineered and designed into the product. Following this belief has always kept us years ahead of industry's reliability needs—and we intend keeping that lead.

FANSTEEL METALLURGICAL CORPORATION
NORTH CHICAGO, ILLINOIS, U. S. A.

FANSTEEL RELIABILITY

Circle 51 on Inquiry Card

New Tech Data for Engineers

Resistor Data

Technical data on precision wire wound and composition variable resistors is offered in a 24-page engineering catalog from Reon Resistor Corp., 155 Saw Mill River Rd., Yonkers, N. Y. Info. is in 2 sections: one on precision wire wound resistors and the other on variable resistors. In the first such subjejcts as: characteristics of resistance wire; coefficient interpretation; "E" temp. coefficient; special coefficients; termination of resistance wire; MIL-R-93B and MIL-R-9444 nomenclature are discussed. The subject matter, second section, includes: MIL-R-94B nomenclature; the Reon part numbering system; interchangeability and a complete chart; summary of test results on Reon variable resistors.

Circle 176 on Inquiry Card

Molded Delrin Parts

An 8-page bulletin released by Gries Reproducer Corp., 400 Beechwood Ave., New Rochelle, N. Y., titled "GRC Injection Molded Tiny Delrin Parts," presents engineering information on "Delrin" a new acetal resin, and outlines established and potential uses.

Circle 177 on Inquiry Card

Test Instruments

Catalog, G-10, 48-pages, gives a brief description, typical illustration, salient specs, and reference for additional information on dc amplifiers, data handling systems, lab & calibration instruments, magnetic tape instrumentation, nuclear instrumentation, oscillographs, recorders & indicators, servo components, temperature controllers, and transducers. Minneapolis-Honeywell Regulator Co., Station M-321, Wayne & Windrim Ave., Phila. 44, Pa.

Circle 178 on Inquiry Card

Position Indicator

Catalog page from Chicago Dynamic Industries, Inc., Precision Products Div., 1725 Diversey Blvd., Chicago 14, Ill. gives technical details, including dimensional drawings and illustrations, of Series 2600 drum type latitude and longitude precision counters completely contained within the movable mask.

Circle 179 on Inquiry Card

Selective Plating

A 4-page illustrated brochure describes Dalic process of electroplating selected areas without using immersion tanks. Sifco Metachemical Inc., 935 E. 63rd St., Cleveland 3, Ohio

Circle 180 on Inquiry Card

Thermostat Metal Parts

Why heat treating of thermostat metal parts is recommended; what cause stresses and redistribution of stresses; and should design compensation be allowed for changes in shape resulting from heat treatment are discussed in a 2-page data bulletin, TRU-9. Data on heat treating temp., length of treatment and quantity of parts treated per load. General Plate Products Group, Metals & Controls Div., Texas Instruments Incorporated.

Circle 181 on Inquiry Card

Instrumentation

1959-60 general catalog, 48-pages, includes technical data on a broad range of pulse instrumentation, including general purpose pulse generators, word generators, time delay generators, and electronic counters. Factors in instrumentation selection and application are covered by detailed technical articles. Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif.

Circle 182 on Inquiry Card

Spectrometer

Technical brochure, illustrated, 4-page, Form 3029-9, on a print-and-plot gamma ray spectrometer. Describes the Victoreen Model ASP-1ADR Precision Automatic Spectrometer. Included are detailed performance and specification data. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio

Circle 183 on Inquiry Card

Volt Ammeter

Hook-on volt ammeter, Bulletin GEA-6292C, 4-pages, gives description, specs and construction details of General Electric's pocket-size, hook-on volt ammeters for testing ac voltages. Lists applications, current ranges, accuracy percentage and operating instructions. General Electric Co., Schenectady 5, N. Y.

Circle 184 on Inquiry Card

Microwave Equipment

Catalog No. 96, 22-pages, on microwave receiver front ends, r-f, i-f, and TWT amplifiers, telemetering preamplifiers, noise test sets and beacons. Includes electrical characteristics, mechanical construction, general applications. New additions described include an X-band low noise microwave mixer-amplifier assembly, a hybrid transistorized amplifier with a ceramic triode input, and a crash locator beacon. Lel, Inc., 380 Oak St., Copiague, L. I., N. Y.

Circle 185 on Inquiry Card

Computer Typewriter

Single-page data sheet describes Alphanumeric Typewriter used with the Bendix G-15 Digital Computer. Every character and symbol has its own code for full and direct input, output and control of the computer. The operator types exactly what he sees on the keyboard, just as in normal typing, for greater speed and versatility. Bendix Computer Div., 5630 Arbor Vitae St., Los Angeles 45, Calif.

Circle 186 on Inquiry Card

Reflex Klystrons

A 4-page catalog on reflex klystrons and rocket planar triodes from Sylvania Electric Products Inc., 730 Third Ave., New York 17, N. Y. gives principal electrical characteristics for 22 klystron types and 9 planar triodes. Tube applications include microwave communication transmitters and receivers, test equipment, beacons and missiles.

Circle 187 on Inquiry Card

Storage Batteries

Detailed operating instructions on stationary type industrial storage batteries are available in a 12-page, illustrated booklet (Form 4676) from Exide Industrial Div., The Electric Storage Battery Co., Rising Sun and Adams Ave., Philadelphia 20, Pa.

Circle 188 on Inquiry Card

Transmitting Equipment

A 4-page, illustrated brochure from Levinthal Electronic Products, Inc., Stanford Industrial Park, Palo Alto, Calif., describes their transmitters, modulators, power supplies and accessories for radar, communications, and tube development. Includes specifications in chart form and applications.

Circle 189 on Inquiry Card

Transistor Notes

August issue of TI Application notes classifies junction transistors in 4 major categories; grown, alloy, electrochemical and diffusion. September issue discusses VHF transistor power stages and the design of VHF power oscillators and amplifiers. Included are theory and design procedures. Texas Instruments Incorporated, Semiconductor-Components Div., P.O. Box 312, 13500 N. Central Expressway, Dallas, Tex.

Circle 190 on Inquiry Card

after routing, clip and save

a continuing series on technical topics of specific interest to engineers

Folio 59-8 **REFERENCE DATA FILE** **SANGAMO**

what is the difference between dissipation factor and power factor?

Approximations, to the engineer, are useful and necessary because the solution of an equation can often be made less laborious in its computation by knowing the weight of each factor and its effect in the final answer. Those factors having little weight can be eliminated and the solution is more easily and readily obtainable, although the answer is a "ball-park" figure. Sometimes one forgets the significance of equality and because approximations are made, quantities become equal to each other under *all* conditions with no limits. The set of conditions under which the approximations were made and for which the solution is valid is simply forgotten. Such is the case of Dissipation Factor and Power Factor with respect to capacitors.

By definition, the Power Factor of a capacitor is the ratio of the Equivalent Series Resistance (ESR) to the impedance (Z). In equation form it would be stated as:

$$\text{Power Factor} = \frac{R}{Z} = \frac{R}{\sqrt{X_c{}^2 + R^2}} \qquad \text{(eq. 1)}$$

Where: R = ESR in ohms

X_c = Capacitive reactance in ohms.

$$[X_c] = \frac{1}{2\Pi fC}$$

f = frequency in cycles per second

C = capacity in farads

Also, by definition, the Dissipation Factor of a capacitor is the ratio of the ESR to the capactive reactance. In equation form it would be stated as:

$$\text{Dissipation Factor} = \frac{R}{[X_c]} = 2\Pi fRC \qquad \text{(eq. 2)}$$

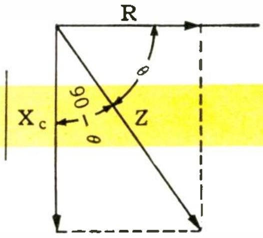


Fig. I

Comparing the two graphically (See Fig. I), several things are apparent.

1. Power Factor $= \frac{R}{Z}$ = Cosine θ; where θ equals the phase angle.
2. Dissipation Factor $= \frac{R}{[X_c]}$ = Tangent (90 — θ); where (90 — θ) equals the loss angle.
3. When θ approaches 90° and 90 — θ approaches 0°, Z approaches $[X_c]$, and R approaches 0.

Now after examining the graphic analysis of Dissipation Factor and Power Factor, certain approximations can be made.

1. If when θ becomes very large, approaching 90°, and Z approaches $[X_c]$, then Z can be considered to be equal to $[X_c]$.
2. If this is assumed, then $\frac{R}{Z} \approx \frac{R}{[X_c]}$ and Power Factor ≈ Dissipation Factor.

When P. F. and D. F. are almost equal to each other, the cosine of θ and the tangent of 90 — θ) are almost equal to each other which can be seen by analyzing Fig. II. You will notice that when θ is large and (90 — θ) is small, the cosine of θ and the tangent of (90 — θ) are almost equal, but as θ decreases and the loss angle increases, the values depart from near equality. At this point, large values of dissipation factor differ appreciably from values of power factor — the limit being: tan 90° = ∞ Cos 0° = 1.

Let's consider a practical example of indiscriminate use of Dissipation Factor and Power Factor. Consider a 500 mfd. electrolytic capacitor rated at 25 WVDC that is being used in a filter circuit for 120 cps. The unit was checked for an ESR of 1.325 ohms and its dissipation factor calculated at .5 or 50%. The reactance at 120 cps. is 2.65 ohms. According to equation 2,

$\text{D. F.} = \frac{1.325}{2.650} = .500 = 50\%$. The phase angle is then approximately 63° and the loss angle is approximately 27°.

If this same ESR were used to calculate Power Factor, equation 1 would yield:

$$\text{P. F.} = \frac{1.325}{\sqrt{(2.65)^2 + (1.325)^2}} = .447 = 44.7\%$$

Also, if ESR were calculated using equation 1 based on a dissipation factor of .5, the ESR would show a value of 1.530, whereas, the actual ESR is 1.325. Not too significant? Perhaps—but there is a difference.

Fig. II

Phase Angle θ	Cosine of Phase Angle θ	Tangent of Loss Angle 90 — θ	Phase Angle θ	Cosine of Phase Angle θ	Tangent of Loss Angle 90 — θ
89.0	.01745	.01745	59.9	.5015	.5797
88.0	.03490	.03492	59.8	.5030	.5820
87.0	.05234	.05241	59.7	.5045	.5844
86.0	.06976	.06993	59.6	.5060	.5867
85.0	.08716	.08749	59.5	.5075	.5890
84.0	.10453	.10510	59.4	.5090	.5914
83.0	.12187	.12278	59.3	.5105	.5938
82.0	.13917	.14054	59.2	.5120	.5961
81.0	.15643	.15838	59.1	.5135	.5985
80.0	.1736	.1763	59.0	.5150	.6009
79.0	.1908	.1944	59.9	.5165	.6032
78.0	.2079	.2126	58.8	.5180	.6056
77.0	.2250	.2309	58.7	.5195	.6080
76.0	.2419	.2493	58.6	.5210	.6104
75.0	.2588	.2679	58.5	.5225	.6128
74.0	.2756	.2867	58.4	.5240	.6152
73.0	.2924	.3057	58.3	.5255	.6176
72.0	.3090	.3249	58.2	.5270	.6200
71.0	.3256	.3443	58.1	.5284	.6224
70.0	.3420	.3640	58.0	5299	.6249
69.0	.3584	.3839	57.9	.5314	.6273
68.0	.3746	.4040	57.8	.5329	.6297
67.0	.3907	.4245	57.7	.5344	.6322
66.0	.4067	.4452	57.6	.5358	.6346
65.0	.4226	.4663	57.5	.5373	.6371
64.0	.4384	.4877	57.4	.5388	.6395
63.0	.4540	.5095	57.3	.5402	.6420
62.0	.4695	.5317	57.2	.5417	.6445
61.0	.4848	.5543	57.1	.5432	.6469
60.0	.5000	.5775	57.4	.5446	.6494

SC—59-9

New Tech Data for Engineers

Single-Crystal Growth

Growth of Single Crystals of Incongruently Melting Yttrium Iron Garnet by the Flame Fusion Process, describes single crystal Yttrium iron garnet ($Y_3Fe_5O_{12}$). Bulletin describes how this was accomplished, diagrams the furnace in which the YIG material was produced in boules etc. Linde Co., Div. of Union Carbide Corp., 30 E. 42nd St., New York 17, N. Y.

Circle 191 on Inquiry Card

Permanent Magnets

Engineering Bulletin, Form 350, on commercial permanent magnet material which achieves typical energy product values of 7 million (BHmax). It describes magnetic and material characteristics of Hyflux Alnico V-7 and applications for the material. A design information service is also offered. The Indiana Steel Products Co., Valparaiso, Ind.

Circle 192 on Inquiry Card

Data Reduction

A 76-page handbook on data reduction and digital control systems from Coleman Electronics, Inc., 133 E. 162nd St., Gardena, Calif., covers the theory behind the Coleman Digitizer, a shaft position encoder. Digitizer systems; input, processing and output components; accessories; and case histories of representative systems.

Circle 193 on Inquiry Card

Power Generators

Catalog F-146, 2-colors, 8-pages, lists over 45 basic models of Onan gasoline and Diesel engine-driven generator sets. Each series is described in detail, with specs. A chart of representative models within each series outlines details such as capacity, model number, voltage, starting method, dimensions and weight. D. W. Onan & Sons Inc., 2515 University Ave. S.E., Minneapolis 14, Minn.

Circle 194 on Inquiry Card

Analog Computer

"Analog Computer CM-2," a 2-page brochure describes and illustrates a solid-state computing device for mathematical calculations, applicable in the chemical, petrochemical, refining and process industries. It lists technical data and specs. Southwestern Industrial Electronics Co., a div of Dresser Industries, 10201 Westheimer Rd., P.O. Box 22187, Houston 27, Tex.

Circle 195 on Inquiry Card

Coaxial Cable Data

Engineering data and coaxial cable selection chart, 16 pages, contains information on selection of correct coaxial cable for various electrical and physical requirements. All types of dielectric and jacketing materials are discussed in detail in both text and chart forms. Attenuation, impedance, and capacitance characteristics of various cable constructions are described and tabulated. Times Wire & Cable Co., Inc., Wallingford, Conn.

Circle 196 on Inquiry Card

! MORE !

The literature mentioned here has been selected for contribution to or advancement of the electronic industries. These items are combed from several hundred bulletins, catalogs, and data sheet announcements received during the past month by ELECTRONIC INDUSTRIES. To keep interested readers informed of all new developments, a summary record is kept of ALL new products and tech data announcements received. For a copy of this month's list, please send your request on company letterhead to Readers' Service Dept., Electronic Industries, 56th & Chestnut Sts., Phila., Penna. or

Circle 258 on Inquiry Card

Power Transistors

Engineering bulletin, Form #1953 covers power transistors, Types 2N1069 and 2N1070. Includes ratings and electrical characteristics charts, curves and other pertinent data. Silicon Transistor Corp., Carle Place, Long Island, N. Y.

Circle 197 on Inquiry Card

Stabilization Network

Bulletin gives description, MIL Spec, approvals, complete specs and applications of both 50-amp and 100-amp models of Line Impedance Stabilization Networks. Stoddard Aircraft Radio Co., Inc.; 6644 Santa Monica Blvd., Hollywood 38, Calif.

Circle 198 on Inquiry Card

Thermocouples

Collection of data-sheets, DCW1-905 to 909, from Advanced Technology Laboratories, Div. of American Standard Corp., 369 Whisman Rd., Mountain View, Calif., gives data on Delta-Couples (Models W1, W2, B1, S1, and S2), a line of miniature thermocouples for accurate point temperature measurement. For surface and in-wall temperature sensing.

Circle 199 on Inquiry Card

Plating Developments

Solutions to the problem of the failure in service of plated printed circuits, are offered in a 4-page article, "Improved Baths Solve Lifting of Plated Circuit Foils." Some problems discussed: lifting or peeling of the copper foil after the circuit has been placed in service; deformation of the di-electric base material; softening of the adhesive or resin binder between copper foil and laminate; and lifting of the electroplated foil due to high tensile stresses. Sel-Rex Corp , Nutley 10, N. J.

Circle 200 on Inquiry Card

Core Design Data

Tape wound cores in two new core materials to precise limits and these materials and limits are illustrated and described in an 8-page, 2-color, illustrated Bulletin TB-105 issued by G-L Electronics, 2921 Admiral Wilson Blvd., Camden 5, N. J. Core design data is included. Diagrams, charts, and tables show the new test limits to precise ranges.

Circle 201 on Inquiry Card

Potentiometers

Eight-page, Fall issue of Helinews has technical information on all-metal single-turn pots; cermet trimming pots; test reports on AC Voltmeters; and servo-motor production. On the light side, there's a modern-day "Uncle Remus" tale and a zany glossary of German missile terms. Helipot Div., Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.

Circle 202 on Inquiry Card

Indicating Amplifier

Data sheet from Keithley Instruments Inc., Cleveland 6, Ohio, describes the Model 603, Electrometer Amplifier. The 603 is a wide-band dc amplifier with a high input impedance, high voltage and current sensitivity and a differential input. Included are Tech specs.

Circle 203 on Inquiry Card

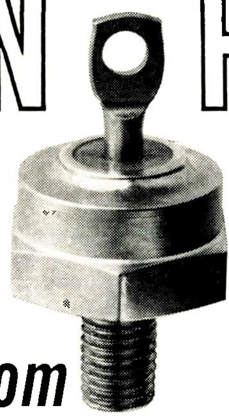
Resistors

Bobbinless, precision, wirewound resistors are described in a Bulletin GR-30 from General Transistor Corp., 91-27 138th Place, Jamaica 35, N. Y. Included are: Comparative Military specs; (requirements or allowable change in resistance); resistor design factors; characteristics; graphs, and outline drawings.

Circle 204 on Inquiry Card

Announcing...

SILICON RECTIFIERS



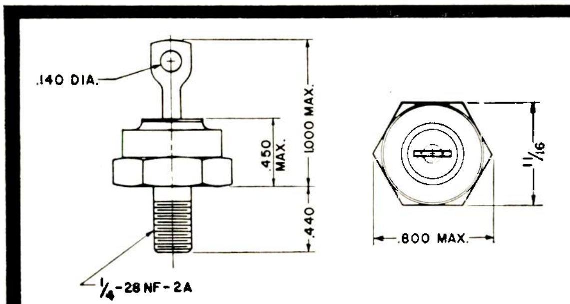
from

DELCO RADIO

High Quality
High Performance
Extreme Reliability

From the leading manufacturer of power transistors, new Silicon Power Rectifiers to meet your most exacting requirements. Even under conditions of extreme temperatures, humidity and mechanical shock, these diffused junction rectifiers continue to function at maximum capacity! Thoroughly dependable, completely reliable—new Delco Rectifiers are an important addition to Delco Radio's high quality semiconductor line.

Conservatively rated at 40 and 22 amperes for continuous duty up to case temperatures of 150°C.



TYPE	AVG. DC CURRENT	PIV	NORMAL MAX. TEMP.	MAX. FORWARD DROP	MAX. REVERSE CURRENT
1N1191A	22A	50V	150°C	1.2V at 60 amps.	5.0 MA
1N1192A	22A	100V	150°C	1.2V at 60 amps.	5.0 MA
1N1193A	22A	150V	150°C	1.2V at 60 amps.	5.0 MA
1N1194A	22A	200V	150°C	1.2V at 60 amps.	5.0 MA
1N1183A	40A	50V	150°C	1.1V at 100 amps.	5.0 MA
1N1184A	40A	100V	150°C	1.1V at 100 amps.	5.0 MA
1N1185A	40A	150V	150°C	1.1V at 100 amps.	5.0 MA
1N1186A	40A	200V	150°C	1.1V at 100 amps.	5.0 MA at 150° C case temperature and rated PIV

For full information and applications assistance, contact your Delco Radio representative.

Newark, New Jersey
1180 Raymond Boulevard
Tel: Mitchell 2-6165

Chicago, Illinois
5750 West 51st Street
Tel: Portsmouth 7-3500

Santa Monica, California
726 Santa Monica Boulevard
Tel: Exbrook 3-1465

Division of General Motors • Kokomo, Indiana

DELCO RADIO

Circle 53 on Inquiry Card

Technical Data for Engineers

Magnetic Tape Recording

A 1500 bit/inch packing density for digital magnetic tape recording is described in a 26-page report from the Potter Instrument Co., Sunnyside Blvd., Plainview, L. I., N. Y. The report, "Digital Magnetic Recording with High Density Using Double Transition Method," includes theoretical considerations with experimental test results. Information drop-out is examined in detail to show performance in this regard exceeding the accepted drop-out rates of existing lower density systems. Descriptions and diagrams for the implementation of this technique are included.

Circle 205 on Inquiry Card

Synchros

Bulletin #69 lists electronic components such as synchros, servomotors, tachometer generators, timers, precision test equipment, variable speed motors, pulse transformers, capacitors, precision potentiometers, coaxial connectors, microwave components, etc., manufactured by Electronic Research Laboratories, Inc., 715-19 Arch St., Philadelphia 6, Pa.

Circle 206 on Inquiry Card

Oscilloscopes

Plug-in units for Textronix oscilloscopes types are described in a 16-page catalog from Textronix, Inc., P.O. Box 831, Portland 7, Ore. The 2-color brochure includes characteristics, general descriptions, specs, and charts and graphs.

Circle 207 on Inquiry Card

Environmental Testing

Four-page brochure covers the range of military and commercial testing available from the Environmental and Performance Testing Div., American Electronic Labs., Inc., 116 N. 7th St., Philadelphia 6, Pa. It outlines AEL's facilities for testing prototype and production equipment in the fields of electronic, electrical and electromechanical with such tests conforming to military and commercial specs.

Circle 208 on Inquiry Card

Tape Tension Gage

The CEC Type 5-050 dynamic tape tension gage for magnetic tape recorder/reproducers is described in bulletin 1621 from DataTape Div., Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

Circle 209 on Inquiry Card

Transistor Replacement

Revised replacement chart for transistors from Semiconductor Products, Red Bank Div., Bendix Aviation Corp., Long Branch, N. J. lists over 298 transistors and their Bendix Type replacement.

Circle 210 on Inquriy Card

Thyratron Controls

Bulletin MTC 558 gives operational data on a line of magnetic thyratron controls. It illustrates operational theory of the magnetic thyratron control and gives typical application circuits. These include: high voltage regulated power supply; 3-phase, full wave ac bridge; low voltage, high current, regulated power supply; 3-phase, half-wave power control; 2-phase ac servo motor position control; 2-phase ac servo motor position control; split field series motor; dc series motor; dc shunt motor; and split field dc servo motor controls. Fairfield Engineering Corp., 934 Hope St., Springdale, Conn.

Circle 211 on Inquiry Card

Hysteresis Motors

Features of a line of precision hysteresis synchronous electric motors for use in tape transports, turntable drives, missile and aircraft instrumentation, computer drum drives flow meters, etc., are explained in a 4-page, 2-color illustrated brochure. It details performance characteristics and dimensions in picture and chart form. Hysyn Electromotive, subsidiary of Telecomputing Corp., 915 N. Citrus Ave., Los Angeles 38, Calif.

Circle 212 on Inquiry Card

Insulating Varnishes

Catalog on the selection and application of electrical insulating varnishes with details on all electrical and mechanical properties as well as operating temperature limitations, is available from Dept. S9-433, Minnesota Mining and Mfg. Co., Irvington Div., 900 Bush Ave., St. Paul 6, Minn.

Circle 213 on Inquiry Card

Communications Towers

Communication Tower Catalog, expanded, includes engineering details and structural data on communication towers. Rohn Manufacturing Co., 116 Limestone Bellevue, Peoria, Ill.

Circle 214 on Inquiry Card

R-F Cable, Connector

A 28-page reference manual, lists r-f cables and connectors, and offers cross references between military and commercial code numbers, a guide for selecting r-f coaxial cable connectors, as well as descriptions and technical data on most types of commonly used connectors. Some information on waveguides, waveguide flanges, and waveguide adaptors is also included. Western International Co., 45 Vesey St., New York 7, N. Y.

Circle 215 on Inquiry Card

Connectors

Two-color, 4-page brochure on the selection of the correct Amphenol AN/MS Connector (MIL-C-5015C and MIL-C-5015D). It shows available AN/MS insert contact arrangements. Schweber Electronics, 60 Herricks Rd., Mineola, L. I., N. Y.

Circle 216 on Inquiry Card

Microwave Instruments

Instruments and Components Catalog, 120-pages, has information on slotted lines and tapered reducers, automatic impedance plotters, coaxial switches, transmission line hybrids, instrument loads, adjustable matching networks and impedance standard lines. Includes technical descriptions, pictures, outline dimensions, circuit diagrams, and electrical and mechanical characteristics, also a summary of data on transmission line connectors. Alford Mfg. Co., 299 Atlantic Ave., Boston, Mass.

Circle 217 on Inquiry Card

Ceramic Capacitors

Two-page catalog bulletin describes line of "VK" ceramic capacitors. Electrical and physical characteristics are described with accompanying charts and drawings covering capacity values to 10,000 mmf. Vitramon Inc., Box 544, Bridgeport 1, Conn.

Circle 218 on Inquiry Card

Automatic Checkout

Illustrated catalog sheet describes the features and general spec of "Demon," universal digital automatic checkout equipment. The equipment, used with appropriate signal sources, can handle a variety of checkout problems of varying degree and complexity. Curtiss-Wright Corp., Sales Dept., 6767 Hollister Ave., Goleta, Calif.

Circle 219 on Inquiry Card

utmost in performance

TYPE 33M

MOLDED mylar* CAPACITOR

applications | *computers • instrumentation • test equipment*
filter networks • transistor circuitry • amplifiers

Sangamo Type 33M molded mylar* capacitors combine the excellent electrical performance characteristics of mylar* dielectric material with a molded case of high moisture resistant thermosetting plastic.

Temperature Range: "The Type 33M is designed to operate over the temperature range of —55°C. to +85°C. Satisfactory performance at 125°C. can be obtained by derating the voltage to 50% of the 85°C. value."

Dissipation Factor: The dissipation factor of the Type 33M capacitor does not exceed 1% at normal equipment operating temperature over the complete audio frequency range.

Tolerances: Available in capacitance tolerance values of ±5%, ±10%, ±20%.

Life Test: These units will withstand a life test of 250 hours at 125% of rated voltage at 85°C. Life tests at 125°C. should be made at 125% of the derated voltage.

Dielectric Absorption: Dielectric absorption of Type 33M capacitors is less than half that of oil impregnated paper capacitors.

Moisture Resistance: Type 33M capacitors will successfully withstand the moisture resistance tests specified in Spec. MIL-C-91A.

Insulation Resistance: The insulation resistance of these capacitors will exceed 5,000 meg/mfd. over the normal operating temperature range.

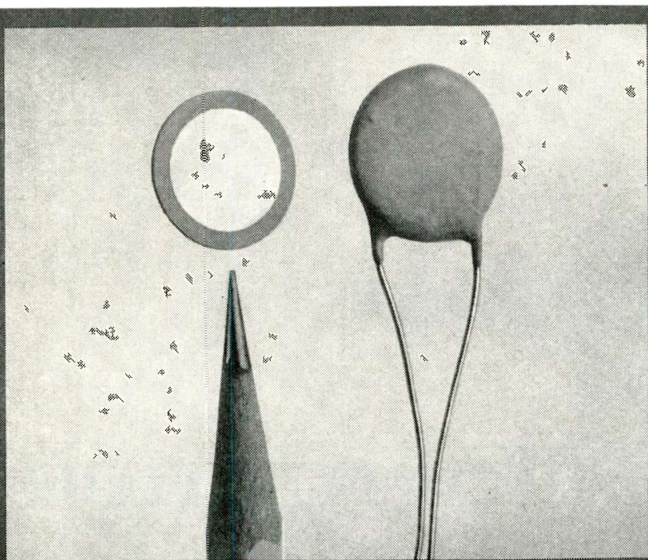
• Write for engineering bulletin SC59-6.

*DuPont's trademark for polyester film.

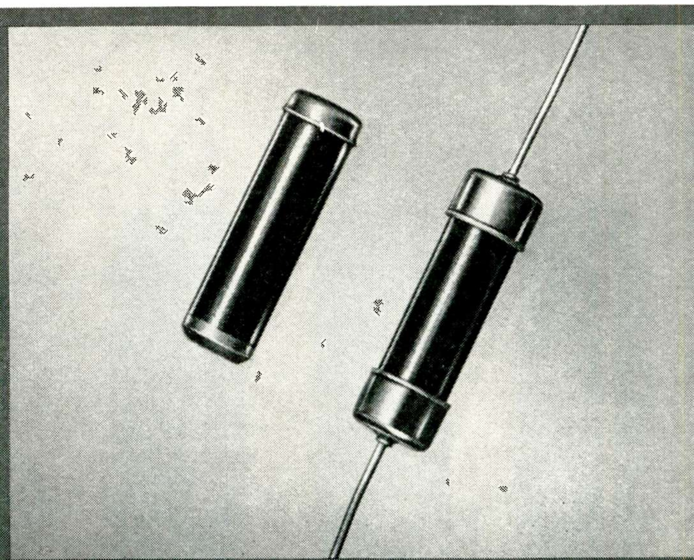
SANGAMO ELECTRIC COMPANY
SPRINGFIELD, ILLINOIS

SC-59-6

Circle 54 on Inquiry Card



• A Du Pont silver coating has been fired onto the barium titanate ceramic capacitor disc shown above. This disc is then solder-dipped to attach wire leads.



• This deposited carbon resistor has been silvered at its ends to attach wire leads. Special Du Pont silver thermosetting compositions are used in this application.

From Du Pont, a complete conductive coatings that save

SILVER—*Du Pont Silver coatings can be applied directly to ceramics . . . give excellent coverage . . . resist corrosion.*

Du Pont has many liquid silver preparations and numerous specialized formulations for virtually every type of electronic circuit and component. These silver conductive coatings can be applied directly, eliminating the need for etching and removal of excess coating material. You get a smooth over-all coverage that is highly conductive while application time is reduced and waste cut to a minimum.

Uses: 1. Electrodes for barium titanate ceramic capacitors; **2.** Electrodes for mica capacitors; **3.** Electrodes for thermistor and piezoelectric bodies; **4.** Thermosetting compositions for application on metals, phenolics, epoxies and other non-ceramic bases; **5.** Firing on ceramic and glass objects (where coating is usually copperplated and tinned for hermetic sealing); **6.** Air-dry types for use on low-temperature, non-ceramic bases (e.g., static shielding).

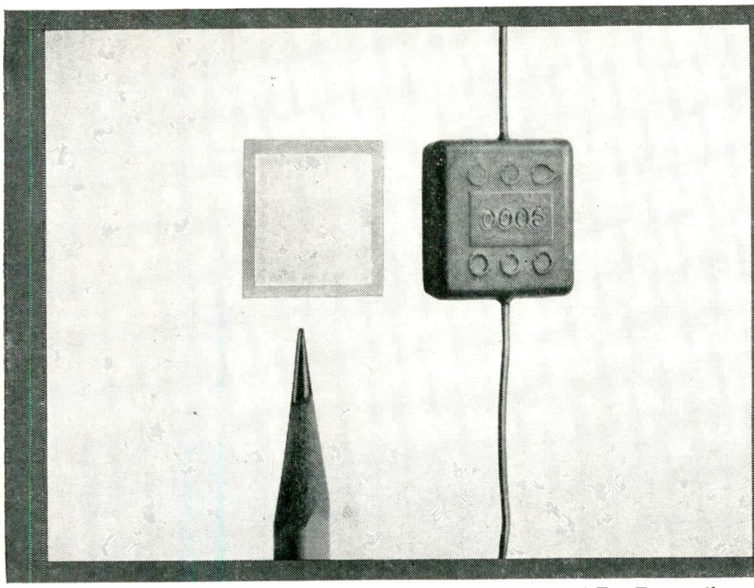
Service: Du Pont will supply specialized silver formulations to fit your application, process or product features. Let Du Pont technicians help in solving your technical problems . . . for more information just write to the address below.

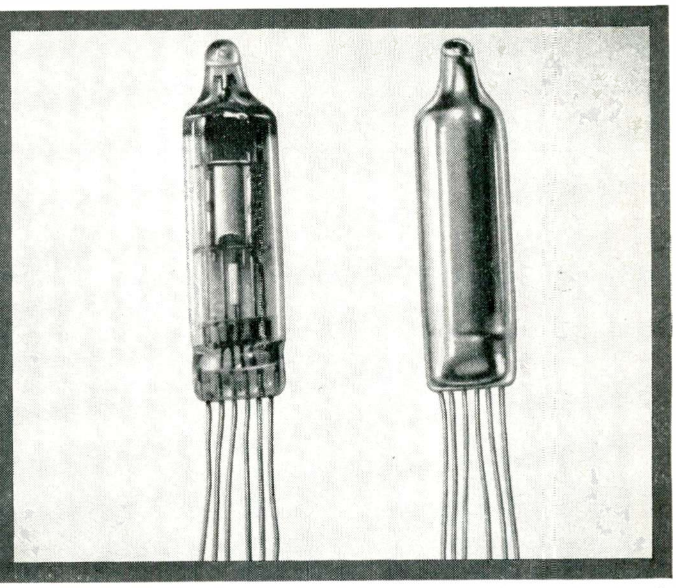
Du Pont Silver, Gold, Palladium and Platinum

DISTRICT OFFICES

Baltimore 2, Md. . . . . 321 Fallsway
Boston, Mass. . . . . 45 Fourth Ave., Waltham 54, Mass.
Charlotte 1, N. C. . . . . 427 W. Fourth St.
Chicago 46, Ill. . . . . . 7250 N. Cicero Ave., Lincolnwood
Cincinnati 2, Ohio . . . . 2412 Carew Tower
Cleveland 20, Ohio . . . . 11900 Shaker Blvd.
Dallas 21, Texas . . . . 8510 Ambassador Row
Detroit 35, Mich. . . . . 13000 W. Seven Mile Rd.
Los Angeles, Calif. . . . . . . P.O. Box 70, El Monte, Calif.
New York 1, N. Y. . . . . 350 Fifth Ave.
Phila., Pa. . . . 308 E. Lancaster Ave., Wynnewood, Pa.
San Francisco 24, Calif. . . . . 1485 Bayshore Blvd.

Export Division . . . Du Pont Building . . . Wilmington 98, Delaware





• This mica film has been coated with special Du Pont silver preparations and is used in the manufacture of silver-mica capacitors (shown above).

• The hearing aid vacuum tube (above right) has been coated with a Du Pont air-dry silver preparation to form a static shield. For information on Du Pont coatings, write address below.

line of specialized you time, effort and money

GOLD

Du Pont's specialized gold preparations can be used alone or in combination with Du Pont silver, palladium or platinum formulations. Gold coatings and cements are especially suitable in the few specialized applications involving migration or where resistance to strong acids is required (e.g., in the manufacture of diodes or transistors).

Use the unique properties of Du Pont gold preparations to solve these and other troublesome electronic problems.

PALLADIUM and PLATINUM

Du Pont palladium conductive coatings form excellent coatings for green ceramic bases that must be fired at extreme temperatures and allow multiple laminations of electroded ceramic sheets.

Du Pont also offers *platinum* preparations that produce coatings with good direct soldering properties. These coatings also may be electroplated.

For more information on any of Du Pont's specialized conductive coatings just write to the address below or call your nearest Du Pont district office.

Conductive Coatings for the Electronics Industry

E. I. DU PONT DE NEMOURS & CO. (INC.)
ELECTROCHEMICALS DEPT., CERAMICS DIVISION
WILMINGTON 98, DELAWARE

DU PONT
REG. U. S. PAT. OFF.

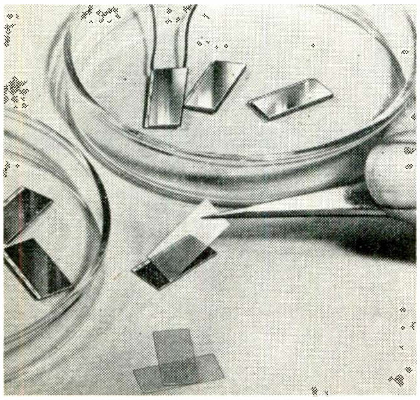
BETTER THINGS FOR BETTER LIVING
... THROUGH CHEMISTRY

Circle 55 on Inquiry Card

New Products . . . for the Electronic Industries

SOLAR CELL COVERGLASS

Optically-coated coverglass for silicon solar cells provide: reduced cell temp. and greater efficiency through increased radiative thermal emissivity; protection of cell surface from

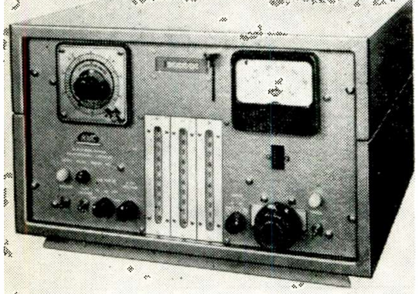


micrometeorite bombardment and abrasion; reflection of that portion of the solar spectrum not effective in solar cell electrical conversion, and furnish an anti-reflection surface to improve the transmission of desired radiation. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

Circle 151 on Inquiry Card

ACTIVITY COUNTER

For detecting and measuring both alpha and beta-gamma activity in prepared samples, the PC-3A proportional counting system is designed for precision counting of H-3, C-14, Ca-45 and S-32. It counts beta radiation in the presence of alpha without absorbers, and alpha in the presence of beta. Yields up to 50% permit

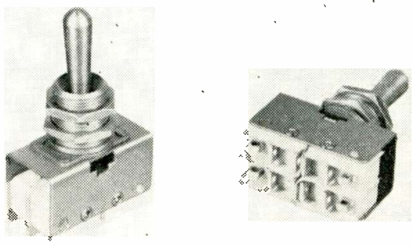


shorter counting time per sample. It can be used as a scaler independently of the proportional counting chamber. Nuclear Measurements Corp., 2460 N. Arlington, Indianapolis 18, Ind.

Circle 152 on Inquiry Card

TOGGLE SWITCH

Toggle switch, Model A3-77, contains 4 poles and occupies less than 1 cu. in. of space below the panel. The bat handle is maintained in one of three positions with the center



position off. Detent action gives positive "feel." Each pole of the switch element is rated at 6 amps, 125/250 vac, 30 vdc, resistive and 3 amps, 30 vdc, inductive. Weight is approximately 1 oz. Exposed parts are stainless steel or corrosion resistant. Electrosnap Corporation, 4218 W. Lake Street, Chicago 24, Illinois.

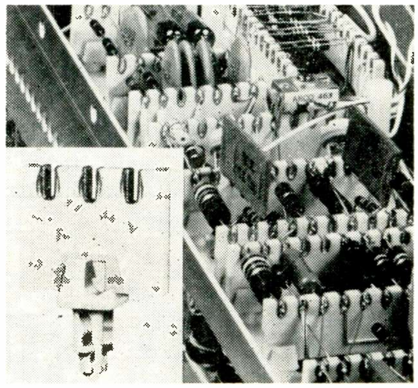
Circle 153 on Inquiry Card

! MORE !

The New Products mentioned here have been selected for contribution to or advancement of the electronic industries. These items are combed from several hundred new product releases received during the past month by ELECTRONIC INDUSTRIES. To keep interested readers informed of all new developments, a summary record is kept of ALL new products received. For a copy of this month's list, please send your request on company letterhead to Readers' Service Dept., Electronic Industries, 56th & Chestnut Sts., Phila., Penna.

TERMINAL STRIPS

Ceramic Terminal Strips with nylon-yoke chassis fittings. A quick snap-fit of the nylon yoke-pin into polypropylene spacer sleeve attaches strip firmly to chassis. Strips come

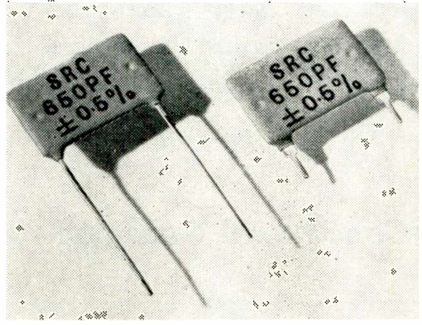


with 1 or 2 nylon yokes assembled. Three sleeve heights available to vary clearance over chassis. Connection will not break or let go under shock or vibration. Available in 7 standard sizes with from 1 to 11 silvered notches, pre-tinned for instant soldering. Tektronix, Inc., P. O. Box 831, Portland 7, Ore.

Circle 154 on Inquiry Card

MICA CAPACITORS

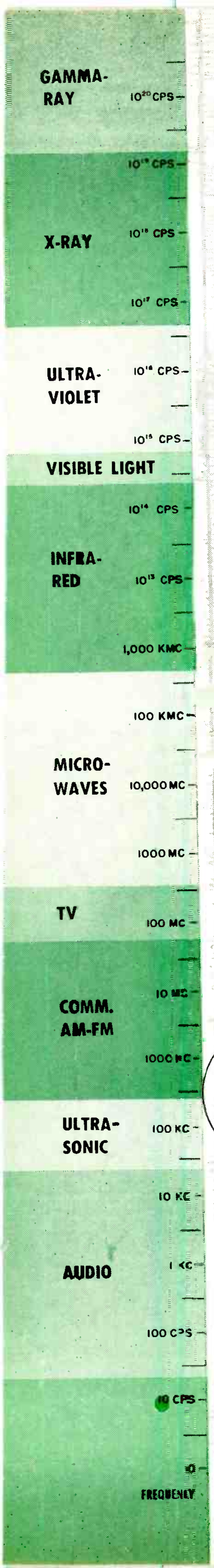
Cement insulated silvered mica capacitors in 7 sizes with overlapping ranges. Conventional leads or printed circuit leads are available. Lead spacing is in modules of 0.1 in. Range is 2 $\mu\mu$F to 10,000 $\mu\mu$F. Tolerance $\pm$0.5 to $\pm$10%. Temp. rating $-60°$C to 100°C. Temp. coefficient aver. $\pm$25 ppm/°C. Voltage rating



500 VDCW (and 1000 VDCW up to 6000 $\mu\mu$F). Long term stability $\pm$0.05%. British Radio Electronics Ltd., 1833 Jefferson Place, N. W., Washington 6, D. C.

Circle 155 on Inquiry Card

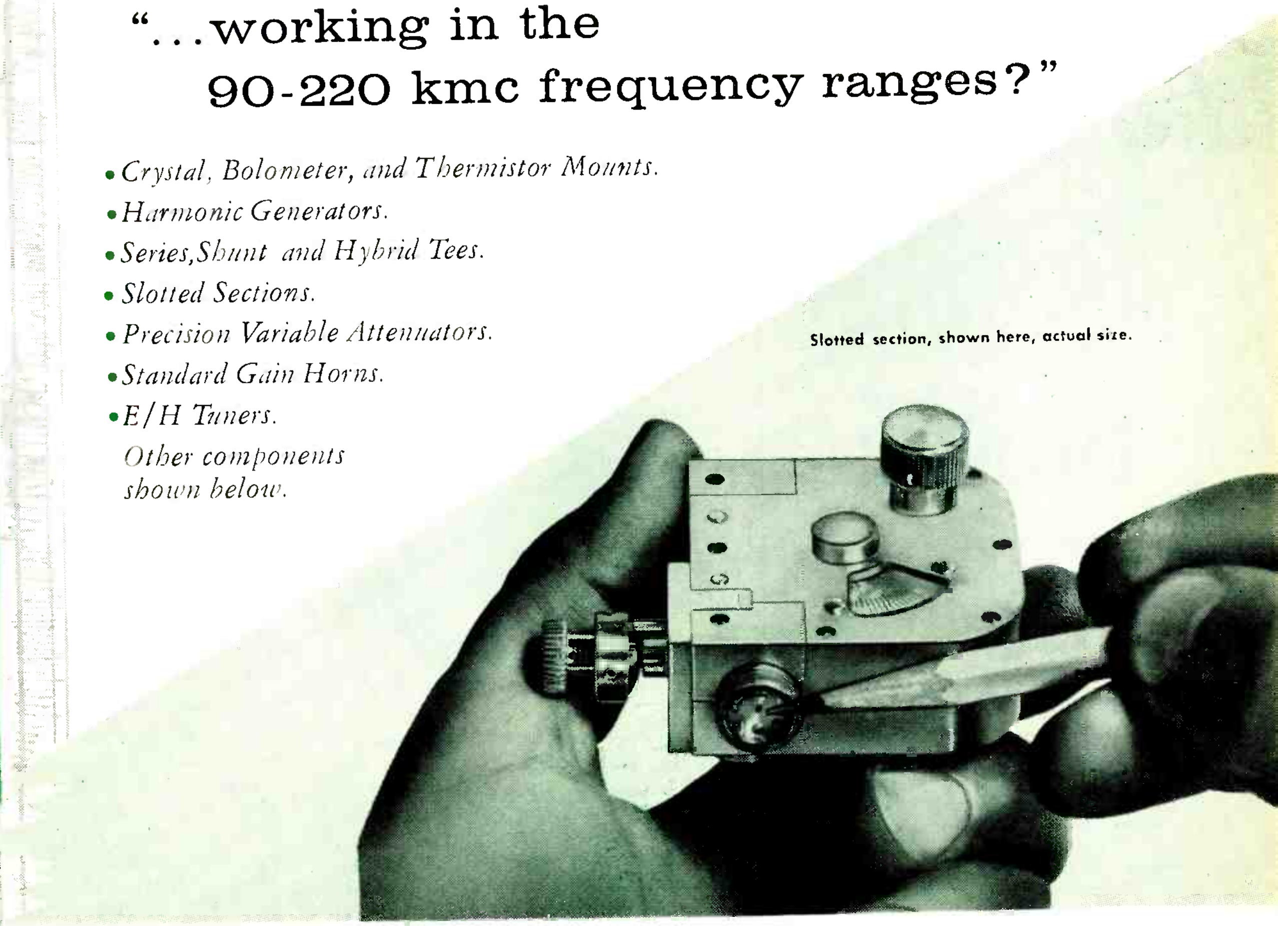
Circle 56 on Inquiry Card →



"...working in the 90-220 kmc frequency ranges?"

- *Crystal, Bolometer, and Thermistor Mounts.*
- *Harmonic Generators.*
- *Series, Shunt and Hybrid Tees.*
- *Slotted Sections.*
- *Precision Variable Attenuators.*
- *Standard Gain Horns.*
- *E/H Tuners.*

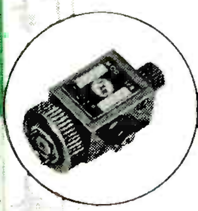
Other components shown below.



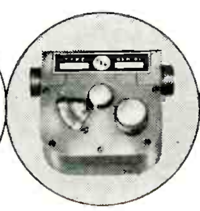
Slotted section, shown here, actual size.

FXR's Newly Developed and Proven 2-3 MM Components are Marvels *of Precision and Reliability*

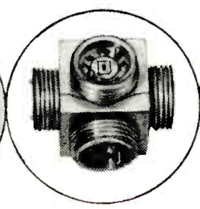
These miniature F-Band and G-Band components are not scaled down versions of their lower frequency counterparts. Rather, they are instruments of individuality and precision — products of advanced microwave engineering and new manufacturing techniques.



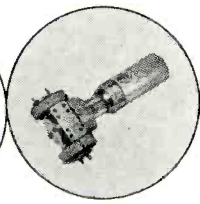
DETECTOR MOUNT



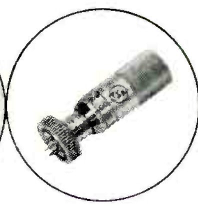
PHASE SHIFTER



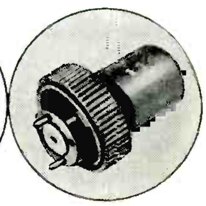
E/H TEE



FREQUENCY METER



ADJUSTABLE SHORT



TERMINATION

Brochure, including price list, available on request!

FXR, Inc.

Design · Manufacture · Development

Woodside 77, N. Y.

Precision Microwave Equipment · High-Power Modulators · Radar Components · Electronic Test Equipment

New Products

POWER SUPPLIES

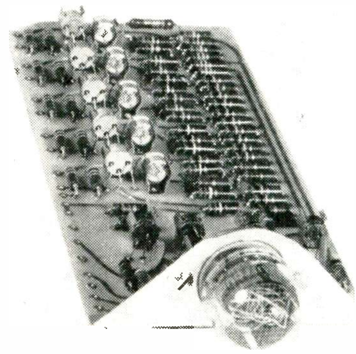
Standard line of transistorized dc converters and an inverter. Converters include 25, 60 and 120 w models. The 25 w inverter delivers 115 or 26 v at 400 CPS. All operate

on 12 to 14 vdc input. Designed to withstand severe environmental conditions, current drain is small. Converter applications include mobile communications, citizens radios, and aircraft radios. Inverters are suitable for synchro position indicators, gyro instruments and remote indicating compasses. Barker & Williamson Inc., Bristol, Penna.

Circle 156 on Inquiry Card

CONVERTER

Solid state Binary to Decimal Converter, Model 260, designed as companion equipment for computers which require decimal display readout for any number of 4 bit code in-

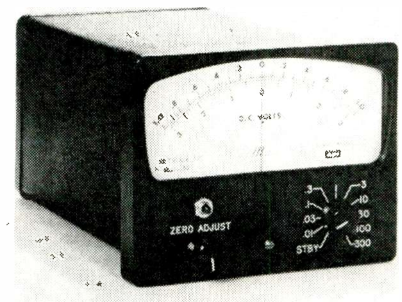


puts. To prevent false readouts and assure reliable operation over a wide range of ambient conditions, solid state techniques are used for conversion and memory functions. All relays and tubes have been eliminated. No preventive maintenance is required. Hermes Electronics Company, 75 Cambridge Parkway, Cambridge 42, Mass.

Circle 158 on Inquiry Card

MILLIVOLTMETER

Chopper-stabilized electronic millivoltmeter measures dc voltages from 0.0005 to 300 v. Power frequency is either 60 or 400 CPS. Model 301 has 10 standard voltage ranges, from 0.01 to 300 v., f.s.d. Two feedback loops achieve operational stability and make it largely independent of voltage variations. An ac loop is in the circuit of the ac square wave

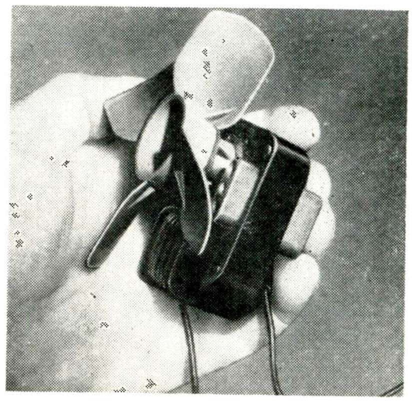


amplifier. A dc loop, including the chopper itself, is established by returning the metered demodulated signal via the chopper to the input of the instrument. Metronix, Inc., Chesterland, Ohio.

Circle 157 on Inquiry Card

ELECTRIC MOTOR

Sealed-in-lubrication, unit-bearing, fractional hp electric motor, the Howard S/L1085, will run for years without attention. Designed for uses such as: cooling electronic data processing machines, driving exhaust fans, operating liquid circulating pumps in machines, and cooling larger electric motors. Characteristics are: 2-pole winding, it can be wound for 110 or



220 50/60 cycle voltage. Rotor turns at 3400 RPM with recommended loads, horsepower ratings 1/750 to 1/185. Operates from −10 to +250°F. Dept. 26, Howard Industries, Inc., 1760 State St., Racine, Wis.

Circle 159 on Inquiry Card

INSIDE PERFORMANCE

OUTSIDE PROTECTION

against water, vapor, dust and time

POTPOT*

POTENTIOMETERS

Select that Clarostat standard wire-wound or composition-element potentiometer (Series 10, 48M, 49M, 43, 37, 51 or 58) for superlative electrical and mechanical characteristics.

Then, if you wish a water- and vapor-tight housing, have it **encapsulated.** That's the Clarostat POTPOT encapsulated control. Completely sealed with exception of external shaft assembly and terminal ends. Special water-tight provision for shaft. Meets MIL-STD-202 Test Specification. Also necessary salt-spray, humidity and temperature cycling requirements of MIL-E-5272.

TECHNICAL DETAILS ON REQUEST

CLAROSTAT

CLAROSTAT MFG. CO. INC., DOVER, NEW HAMPSHIRE
In Canada: Canadian Marconi Co., Ltd., Toronto 17, Ont.

*Reg. U.S. Pat. Off.

(Part Two of Two Parts)

ELECTRONIC INDUSTRIES'

1960 Summary of

Microwave Electron Devices

Listing complete technical specifications on the commercially available microwave electron tubes, both foreign and domestic. This section covers klystrons, traveling wave tubes, backward wave tubes and planar triodes and tetrodes. (Magnetrons and parametric amplifiers were covered in Part I, which appeared in the November 1959 issue.)

Klystrons

AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L.I., N.Y.

Type	Descr. App.	Freq. (kmc)	Heater V.A.	Beam V.	Beam A.	Refl. V.	Duty Cy.	Tun. Range	Type Out.	Pwr. Out.
55334	refl. OSC multf.	3.336, 3.414	6.3, 0.75	3k	0.024	850				10w
2K25	refl. OSC	8.5, 9.66	6.3, 044	300	0.025	200				25mw
DX122	OSC 2 cav. fix. freq.	8.5, 10.5	11, 1.2	2.75k	0.035					5w
DX123	OSC 2 cav- fix. freq.	8.5, 10.5	11, 1.2	4.35k	0.071					33w
DX124	OSC 2 cav. fix. freq.	8.5, 10.5	11, 1.2	8.8k	0.180					210w
723A/B	refl. OSC	8,702, 9.548	6.3, 4.4	300k	0.025	185				30mw
DX184	refl. OSC	31, 36	6.3, 0.8	2.25k	0.015	500				100mw
DX151	refl. OSC	68, 75	3.5, 1.8	2.4k	0.017	300				100mw

BENDIX AVIATION CORPORATION, Red Bank Division, Eatontown, N. J.

Type	Descr. App.	Freq. (kmc)	Heater V.A.	Beam V.	Beam A.	Refl. V.	Duty Cy.	Tun. Range	Type Out.	Pwr. Out.
6541	CW OSC	23.2-24.7		330						8.5mw
6584	CW OSC	5.1-5.9		330						70mw
6845	CW OSC, mil spec	8.5-9.6		350						20mw
TE37	CW OSE	34-35.6		425						8.5mw
TE60	CW OSC	23.5-24.5		330						8.5mw
TE61	CW OSC	10.52		350						20mw
6116/TE-39	refl. OSC	8.5-9.66								
6940/TE-58	refl. OSC	5.2-10.9								
6845/TE-59	refl. OSC	8.5-9.6								
TE-4	refl. OSC	23.5-24.4								
TE-62	refl. OSC	8.5-9.66								
TE-30	refl. OSC	23.5-24.5								
TE-38	refl. OSC	5.1-5.9								
TE-53	refl. OSC	34-35.6								

BOMAC LABORATORIES, INC. Salem Road, Beverly, Mass.

Type	Descr. App.	Freq. (kmc)	Heater V.A.	Beam V.	Beam A.	Refl. V.	Duty Cy.	Tun. Range	Type Out.	Pwr. Out.
6780/BL800	CW OSC	8.5-10.								10mw
6316/BL800A	CW OSC	8.5-10.								35mw
BL801	CW OSC	8.5-10.								100mw
BL802	CW OSC	8.8-9.2								5mw
BL803	CW OSC	8.5-10.								25mw
BL806	CW OSC	8.5-10.								25mw
BL-807		8.5-10.5								50mw
BL811		8.5-10								25mw
BL812		8.5-9.6								120mw
BL814		10.4-12.3								150mw
BL815		9.14-9.15								15mw
BL818		8.5-10.5								50mw
BL819		9.192								40mw
BL820		9-9.2								40mw
BL824		9.2-9.5								22mw

BRITISH INDUSTRIES CORP., 80 Shore Road, Port Washington, N.Y. (Representing General Electric Co., Ltd.)

Type	Descr. App.	Freq. (kmc)	Heater V.A.	Beam V.	Beam A.	Refl. V.	Duty Cy.	Tun. Range	Type Out.	Pwr. Out.
KLX1	4-cav. c, w,	9.0, 9.6[1]	4.1, 4.8	11k	0.3			±30mc		1130w
KLS2	3-cav. c, w,	2.65	5, 9.5	10k	1			±50mc		1700w.

1. can be manufactured to operate at any frequency in this range.

Type	Descr. App.	Freq. (kmc)	Heater V. A.	Beam V.	Beam A.	Refl. V.	Duty Cy.	Tun. Range	Type Out.	Pwr. Out.
EITEL-McCULLOUGH, INC., 301 Industrial Way, San Carlos, Calif.										
3K2500LX	3-gap, ampl.	0.98-1.2	7.5, 5.8	7k	0.6		cw			1.32kw
3K2500SG	3-gap, ampl.	1.7-2.4	7.5, 5.5	7k	0.6		cw			1.3kw
3K3000LQ	3-gap, ampl.	0.72-0.985	5, 31	9k	0.75		cw			2.79kw
3K50, 000LA	3-gap, ampl.	0.4-0.6		17.2k[1]	2.15[1]					12kw
3K50, 000LF	3-gap, ampl.	0.57-0.72		20k	2.5					
3K50, 000LQ	3-gap, ampl.	0.72-0.985		15k[1]	1.65[1]		cw			10.7kw
3KM3000LA	3-gap, ampl.	0.385-0.580	5, 31	9k	0.75		cw			2.3kw
3KM4000LT	3-gap, ampl.	0.96-1.215	7.5, 5.5	28k[2]	6[2]		plse			38.2kw
4K50, 000LQ	4-gap, ampl.	0.72-0.985	8, 40	20k	2.5		cw			11.2kw
4KM3000LQ	4-gap, ampl.	0.72-0.985	5, 32	10k	0.75		cw			1.05kw
4KM3000LR	4-gap, ampl.	0.61-0.985	5,32	10k	0.75		cw			1.05kw
4KM50, 000LA	4-gap, ampl.	0.4-0.61	7.5, 40	20k	2.5		cw			10kw
4KM50, 000LQ	4-gap, ampl.	0.61-0.985	7.5, 40	20k	2.5		cw			10kw
4KM50, 000SG	4-gap, ampl.	1.7-2.4	7.5, 40	18k	2		cw			11.4kw
6K50, 000LQ	6-gap, ampl.	0.72-0.98	8, 40	20k	2.5		cw			9kw
1K015CA	refl. OSC	5.4-6	6.3, 0.8	350	.05		cw		Co	0.1w
1K015CG	refl. OSC	5.4-6	6.3, 0.8	350	.05		cw		Wg	0.1w
1K20KA	refl. OSC	10.7-11.7	6.3, 0.8	350	.05		cw		Wg	40mw
1K20XD	refl. OSC	10-10.7	6.3, 0.8	350	.05		cw		Wg	40mw
1K20XK	refl. OSC	9.2-10	6)3, 0.8	350	.05		cw		Wg	40mw
1K20XS	refl. OSC	8.5-9.2	6.3, 0.8	350	.05		cw		Wg	40mw
1K125CA	refl. OSC	3.7-4.4	6.3, 1.2	1K	0.11		cw		Wg	1.8w
1K125CB	refl. OSC	4.4-5	6.3, 1.2	1K	0.11		cw		Wg	2.3w
X756	refl. OSC	4.3± 50mc	6.3, 1.1	850	0.7	-350		30mc	TNC	1w
X700	refl. OSC	2.4-2.9							Wg	20kwp
X571J	3-cav. ampl.	1.7-2.4					cw			1kw
1. Typical operating values. 2. Pulsed.										
ENGLISH ELECTRIC VALVE CO., LTD., Chelmsford, England										
K300	refl. OSC int. res.	9.32-9.5	6.3, 0.6	350	.044	-150		30mc	Wg	30mw
K301	refl. OSC, ext. res.	2.5-3.5	6.3, 0.6	350	.044	-400		15mc		30mw
K302	refl. OSC	9.32-9.5	6.3, 0.6	350	.044	-165		30mc	Wg	30mw
K305	refl. OSC	9.25-9.5	6.3, 0.6	350	.044	-170		35mc	Wg	25mw
K308	refl. OSC	8.8-8.9	6.3, 0.6	350	.044	-220		40mc	Wg	40mw
K311	ref. OSC	8.5-9.5	6.3, 0.6	350	.044	-365		30mc	Wg	45mw
K312	refl. OSC	9.43-9.65	6.3, 0.6	350	.044	-180		30mc	Wg	30mw
K313	refl. OSC	9.645-9.775	6.3, 0.6	350	.044	-185		30mc	Wg	25mw
K315	refl. OSC	9.105-9.205	6.3, 0.6	350	.044	-270		30mc	Wg	20mw
K317	refl. OSC	8.2-8.3	6.3, 0.6	350	.044	-320		30mc	Wg	20mw
K321	refl. OSC	9.43-9.65	6.3, 0.6	350	.044	-180		30mc	Wg	25mw
K323	refl. OSC	9.645-9.775	6.3, 0.6	350	.044	-185		30mc	Wg	25mw
K324	wide band OSC	9-10	6.3, 0.6	350	.040	-400		30mc	Wg	45mw
K328	refl. OSC	9.555-9.685	6.3, 0.6	350	.044	-190		30mc	Wg	25mw
K335	refl. OSC	9.555-9.685	6.3, 0.6	350	.044	-180		30mc	Wg	25mw
K337	wide band OSC, rugg.	9-10	6.3, 0.6	350	.035	-400		24mc	Wg	30mw
K340	refl. OSC	9.3-9.5	6.3, 0.6	300	.030	-175		40mc		35mw
K342	refl. OSC	8.5-9	6.3, 0.6	350	.040	-275		35mc	Wg	45mw
K343	wide band OSC	12-14.5	6.3, 0.6	350	.040	50-250				40mw
						100-350		50mc	Wg	50mw
K345	refl. OSC	5.9-8.025	6.3, 0.8	750	.080	-400		30mc	Wg	1.0w
K346	wide band OSC	14.5-17	6.3, 0.6	350	.040	50-200		120mc	Wg	35mw
								75mc		45mw
K347	hi pwr, 3-cav.	0.58-0.61	7.0, 35	78k	10	78k	.0024		Co	600kw
K350	2-res. OSC	8.5-10	6.3, 1.7	1000	0.13			12mc	Wg	1.2w
K351	refl. OCS, int. res.	8.5-9.6	6.3, 1.2	300	.040	80-185		35mc	Wg	65mw
				250	.030	40-120		42mc		30mw
K352	refl. OCS, int. res.	2.998±0.005	5.0, 100	190k	200pk					6000kw
K353	refl. OCS, int. res.	10.5-12.2	6.3, 1.2	400	.060	150-450		60mc		250w
				300	.045	150-450		50mc		100w
K357	refl. OSC, int. res.	10.7-10.6	6.3, 0.6	250	.015	80-130		40mc		12w
K358	refl. OSC	10.5-12.2	6.3, 1.2	400	.070	-450		60mc	Wg	250mw
GENERAL ELECTRIC COMPANY, Electronic Components Div., One River Road, Schenectady 5, N. Y.										
GL-6237 to GL-6242	3-res., tun. TV ampl.	0.47-0.89 (in 6 steps)	5.5, 35	18k	3					12kw
GL-6625	3-res., tun. plsd. ampl.	0.9-1.215	5.5, 45	20k	9.35		12%		Co	22kw
Z-3044	5-cav. ampl.	8.5-9.6	7, 7	55k	14		.003		Wg	150kwpk
Z-3047	5-cav. ampl.	8.5-9.5	10, 10	115k	40		.002		Wg	1megw
Z-3063	4-cav. ampl.	7.5-8.5	10, 2.5	22k	1.7		.001		Wg	6kw
Z-3057	3-cav. ampl.	L-Band	16, 16	278k	147		.0015		Wg	15megw
Z-5095	4-cav.	8.5-9.6	7.5, 8	53k	15.5		.0025		Wg	200kw
Z-5096	3-cav. gang tun.	8.5-9.5	8, 8	115k	42		.002		Wg	1megw
Z-5214	4-cav. cw ampl.	7.5-8.5	10, 2.5	10k	0.55				Wg	1kw

Klystrons

Type	Descr. App.	Freq. (kmc)	Heater V. A.	Beam V.	Beam A.	Refl. V.	Duty Cy.	Tun. Range	Type Out.	Pwr. Out.
LITTON INDUSTRIES, Electron Tube Division, 960 Industrial Road, San Carlos, Calif.										
L3283	broad band	1.25-1.35					.003			2mw
L3270	broad band	1.25-1.35					.003			2mw
LT7504	radar	1.24-1.36					.003			2.2mw
L3257	lin. accel.	1.28-1.33					.0003			4mw
L3227	lin. accel.	1.28-1.33					.002			5mw
L3250	radar & lin. accel.	1.25-1.35					.0015			10mw
L3302	lin. accel & radar	2.75-2.95					.0015			10mw
L3355	radar	1.25-1.35					.0015			20mw
MICROWAVE ELECTRONIC TUBE CO., INC., 76 Lafayette St., Salem, Mass.										
6310	refl. OSC	8.5-10		300		-250			Wg	40mw
6312	refl. OSC	8.5-10		300		-250			Wg	40mw
6314	refl. OSC	8.5-10		300		-250			Wg	40mw
6315	refl. OSC	8.5-10		250		-120			Wg	30mw
6316	refl. OSC	8.5-10		300		-250			Wg	35mw
6781	refl. OSC	8.5-10		300		-200			Wg	40mw
6975	refl. OSC, ext. cav.	8.5-9.6		300		-250			Wg	30mw
MXK-12	refl. OSC, temp. comp	8.5-10		300		-200			Wg	40mw
MXK-19	refl. OSC	8.5-10		300		-200			Wg	35mw
MULLARD OVERSEAS LIMITED, Mullard House, Torrington Place, London, W.C.1										
KC9-250w	mult. cav.	9.2-9.5	6.3, 4	64k	16		10	50	Wg	250w
KS7-1000C	refl. OSC	6.9-7.1	6.3, 0.8	800	80	1K	cw		Wg	1.1w
KS7-85	refl. OSC	6.2-7.1	6.3, 0.5	330	35	350	cw		Co	0.1w
KS7-85A	refl. OSC	6.2-7.4	6.3, 0.5	330	35	350	cw		Co	0.11w
KS9-20	refl. OSC	8.7-9.5	6.3, 0.6	330	32	400	cw		Co	25mw
KS9-20A	refl. OSC	8.5-9.7	6.3, 0.6	330	37	400	cw		Co	35mw
KB9-2	mult. cav.	9.3-9.4	7, 2	1.6k	45		cw		Wg	2w
KB9-150W	mult. cav.	8.6-10	6.3, 0.8	10k	250	10k	cw		Wg	200w
KS9-40	refl. OSC	9.0-9.5	6.3, 0.7	350	40	400	cw		Wg	40mw
RAYTHEON MANUFACTURING COMPANY, Microwave and Power Tube Operations, Waltham, Mass.										
5837	OSC	0.55-3.8		325		235		12		160mw
RK-5777	OSC	0.6-2.35		400		625		8		160mw
707B	OSC	1.5-3.75		300		300		20		140mw
2K28A	OSC	1.5-3.75		300		277		20		140mw
5981	OSC	1.245-1.46		225		220		2.5		100mw
RK-5778	OSC	1.8-4.62		300		460		8		150mw
6BL6	OSC	1.6-5.5		300						121mw
5836	OSC	1.6-5.5		300				6		121mw
5721	OSC	2-12		1250				12		150mw
6236	OSC	3.8-7.6		1k		510		10		125mw
726C	OSC	2.7-2.96		300		135		25		100mw
6043	OSC	2.95-3.275		300		175		20		175mw
2K29	OSC	3.4-3.96		300		180		28		106mw
2K56	OSC	3.84-4.46		300		150		30		100mw
QK381	OSC	4.1-4.45		250		87		30		4.5mw
2K22	OSC	4.24-4.91		300		180		30		115mw
2K48	OSC	4-11		1250		300				20mw
6115A	OSC	5.1-5.9		300		175		30		100mw
QK412	OSC	5.1-5.9		300		160				100mw
RK6037	OSC	5.12-5.43		300		160		40		30mw
QK461	OSC	5.925-6.45		300		175		30		120mw
QK404	OSC	5.925-6.45		300		275		20		120mw
QK549	OSC	5.925-6.45		300		275		20		120mw
5976	OSC	6.2-7.425		300		158		32		100mw
2K26	OSC	6.25-706		300		115		32		100mw
QK531	OSC	6.575-6.875		300		285		32		110mw
QK532	OSC	6.875-7.125		300		305		32		110mw
QK623	OSC	7.125-7.65		300		380		32		110mw
QK422	OSC	7.125-8.125		300		225		20		150mw
RK6390	OSC	6.87-10.75		1250		420		6		80mw
RK6310	OSC	8.5-10		300		170		48		70mw
RK6312	OSC	8.5-10		300		170		48		70mw
RK6316	OSC	8.5-10		300		170		48		70mw
2K25	OSC	8.5-9.66		300		183		64		32mw
2K45	OSC	8.5-9.66		300		145		70		32mw
6116	OSC	8.5-9.66		300		145		70		32mw
6940	OSC	8.5-9.66		300		145		70		32mw
QK414	OSC	9.66-10.25		300		183		50		20mw
QK448	OSC	12-13		300		275		60		85mw
QK510	OSC	12-13		300		275		60		85mw
RK6178	OSC	15.75-16.25		300		200		75		25mw
QK246	OSC	15-16.2		1.5k		173		25		51mw

Type	Descr. App.	Freq. (kmc)	Heater V. A.	Beam V.	Beam A.	Refl. V.	Duty Cy.	Tun. Range	Type Out.	Pwr. Out.
RAYTHEON MANUFACTURING COMPANY, Microwave and Power Tube Operations, Waltham, Mass. (cont'd.)										
RK6573	OSC	15.5-17		300		210		75		25mw
QK306	OSC	18-22		1.8k		220		40		40mw
6253	OSC	18-22		1.8k		220		40		40mw
2K33	OSC	22-25		1.8k		220		40		40mw
6254	OSC	22-25		1.8k		220		40		40mw
QK463	OSC	24.5-27.5		1.8k		250		40		40mw
QK289	OSC			2.25k		200		45		20mw
QK290	OSC			2.25k		200		45		20mw
QK291	OSC			2.25k		200		45		18mw
QK288	OSC	34.3-35.3		2.25k		210		50		20mw
QK292	OSC			2.25k		200		45		10mw
QK293	OSC	34.9-42.8		2.5k		200				5mw
QK294	OSC	40-51.8		3k		200				5mw
QK295	OSC	50-60(2)		3.5k		200				
QK661	OSC	7.125-8.5		1k	0.1	500		36		1.8w
QK754	OSC	5.925-6.425		1k	0.1	500		50		1.8w
SPERRY GYROSCOPE COMPANY, Great Neck, N. Y.										
219	3-res. ampl.	9.6-12.15								37kw
SAL81	3-res. ampl.	12.15-13.65		20k						21kw
SAL89	3-res. ampl.	9.6-12.15		20k						30kw
SAS28	3-res. ampl., CW	2.6-2.7		4k						225w
SAS-60,A	3-res. ampl., CW	2.67-3.33		1k						25w
SAS-60B	3-res. ampl.	2.7-2.93		1400						20w
SAS-61		2.7-2.9		15k						15kw
SAC-9	3-res. ampl., CW	4.97-5.09		1000						9w
SAC-19	2-res. CW ampl., OSC	5.8-6.42		625						6w
SAC-33	3-res. ampl., CW	4.8-5.3		5400						500w
SAC-41	3-res. ampl., CW	3.7-4.2		750						30w
SMS-27	2-res. freq. mult. 1/10	2.6-2.7		1250						0.5w
SMC-11	2-res. freq. mult. 1/6	4.5-5.7		1000						1w
SMX-32	3-res. ampl., freq. mult. 1/2	9.0-10.5		1000						3.5w
SMK-40	3-res. ampl., freq. mult. 1/5	23.5-26.0		1500						0.6w
SOC-150	3-res. CW OSC	4.91-5.01		1100						11w
SOU-201	2-res. CW OSC	12.5-15.0		1700						15w
SRL-7	refl. CW OSC	1.7-2.4		1000						10w
SRL-17	refl. CW OSC	0.75-0.98		1000						3w
5981	refl. CW OSC	1.24-1.46		250						0.17w
2K41	refl. CW OSC	2.66-3.31		1250						2.75w
SRC-43	refl. CW OSC	5.92-7.72		900						1.5w
2K42	refl. CW OSC, mil spec	3.3-4.2		1250						1.5w
2K43	refl. CW OSC, mil spec	4.2-5.7		1250						1.25w
2K44	refl. CW OSC, mil spec	5.7-7.5		1250						1w
SRX-53	refl. CW OSC	7.0-8.5		500						100mw
SRX-92	refl. CW OSC	8.5-10.5		330						60mw
2K25	refl. CW OSC, mil spec	8.5-9.66		300						30mw
2K39	refl. CW OSC, mil spec	7.5-10.3		1250						1w
SRU-55	refl. CW OSC	14.5-17.0		300						75mw
SRU-55A	refl. CW OSC	15.7-17.0		350						25mw
SRU-95	refl. CW OSC	12.4-15.5		300						52mw
SRU-210	refl. CW OSC	15.7-17.0		300						20mw
SRV-38	refl. CW OSC	33.0-36.0		425						40mw
SRV-215	CW OSC	34.2-35.4								5mw
SRU-216	CW OSC	15-17								20mw
SYLVANIA, Special Tube Operations, 500 Evelyn Ave., Mountain View, Calif.										
6BM6	CW, ext. cav. 1¾ mode	0.55-2.3	6.3	325	18	-235[1]				175mw[1]
	2¾ mode	1.1-3.0	6.3	300	15	-200[2]				70mw[2]
	3¾ mode	1.5-3.8	6.3	325	18	-250[3]				50mw[3]
6BM6A	CW/pulsed 1¾ mode	0.5-2.3	6.3	325	18	-235[1]				175mw[1]
	2¾ mode	1.1-3.0	6.3	300	15	-200[2]				70mw[2]
	3¾ mode	1.5-3.8	6.3	325	18	-250[3]				50mw[3]
5837	CW/pulsed 1¾ mode	0.55-2.3	6.3	325	28	-235[1]				175mw[1]
	2¾ mode	1.1-3.0	6.3	300	28	-215[2]				70mw[2]
	3¾ mode	1.5-3.8	6.3	325	28	-215[3]				50mw[3]
6BL6	CW, ext. cav 1¾ mode	1.6-4.0	6.3	325	28	-200[4]				250mw[4]
	2¾ mode	2.1-4.5	6.3	325	26	-120[5]				100mw[5]
	3¾ mode	3.6-6.5	6.3	325	25	-200[6]				60mw[6]
5836	CW/pulsed 1¾ mode	1.6-4.0	6.3	325	28	-220[4]				250mw[4]
	2¾ mode	2.1-4.5	6.3	325	26	-120[5]				100mw[5]
	3¾ mode	3.6-6.5	6.3	325	25	-220[6]				60mw[6]
6974	CW, int. cav 2¾ mode	4.6-5.0	6.3	800	100max	-410				2w
6468	CW, int. cav. 3¾ mode	6.125-6.425	6.3	750	80max	-400				1w
	5¾mode	6.125-6.425	6.3	500	48max	-400				100mw
6469	CW, int. cav. 3¾ mode	6.575-6.875	6.3	750	80max	-400				1w
	5¾ mode	6.575-6.875	6.3	500	48max	-150				100mw

Type	Descr. App.	Freq. (kmc)	Heater V. A.	Beam V.	Beam A.	Refl. V.	Duty Cy.	Tun. Range	Type Out.	Pwr. Out.
SYLVANIA, Special Tube Operations, 500 Evelyn Ave., Mountain View Calif. (cont'd.)										
6470	CW, int. cav. 3¾ mode	7.125-7.425	6.3	750	80max	-400				1w
	5¾ mode	7.125-7.425	6.3	500	48max	-150				100mw
K-839B	CW, int. cav. 3¾ mode	6.125-7.425	6.3, 0.9	750	80max	-400		60mc		1w
K-840B	CW, int. cav. 3¾ mode	6.575-6.875	6.3	750	80max	-400				1w
K-841B	CW, int. cav. 3¾ mode	6.125-6.425	6.3	750	80max	-400				1w
K-4160	CW, int. cav. 3¾ mode	7.125-7.425	6.3, 0.9	750	80max	-400			Wg	1w
K-4161	CW, int. cav. 3¾ mode	6.575-6.875	6.3	750	80max	-400			Wg	1w
K-4162	CW, ext. cav. (int.) 3¾ mode	6.125-6.425	6.3, 0.9	750	80max	-400			Wg	1w
K-4011	CW, int. cav. 3¾ mode	6.875-7.5	6.3	750	70	-360				1400mx[7]
	4¾ mode	6.8-7.425	6.3	500	42	-190				330mw[7]
	4¾ mode	6.3-6.7	6.3	300	18	-185				90mw[7]
	5¾ mode	6.3-7.125	6.3	300	18	-150				50mw[7]
K-4010	CW, int. cav. 3¾ mode	6.5-7.125	6.3	750	70	-390				1400mw[7]
	4¾ mode	6.2-6.9	6.3	500	42	-200				360mw[7]
	4¾ mode	5.8-6.2	6.3	300	18	-180				100mw[7]
	5¾ mode	5.8-6.6	6.3	300	18	-130				60mw[7]
K-4009	CW, int. cav. 3¾ mode	6.0-6.6	6.3	750	70	-390				1300mw[7]
	4¾ mode	5.9-6.5	6.3	500	42	-210				330mw[7]
	4¾ mode	5.3-5.9	6.3	300	18	-210				100mw[7]
	5¾ mode	5.3-6.2	6.3	300	18	-150				60mw[7]
K-4008	CW, int. cav. 3¾ mode	5.9-6.3	6.3	750	70	-380				1200mw[7]
	4¾ mode	5.7-6.3	6.3	500	42	-215				360mw[7]
	4¾ mode	5.3-5.8	6.3	300	18	-220				100mw[7]
	5¾ mode	5.3-6.0	6.3	300	18	-150				60mw[7]
K-4184	ext. cav.(int.) 3¾ mode	7.125-7.425	6.3	750	80max	-400				1w
K-4186	ext. cav.(int). 3¾ mode	6.575-6.875	6.3	750	80max	-400				1w
K-4188	ext. cav.(int.) 3¾ mode	6.125-6.425	6.3	750	80max	-400				1w
6974	CW, int. cav.	4.6-5	6.3, 0.9	825	110max	-500			Wg	1w
(NOTES): 1. at 1.5kmc; 2. at 2.2kmc; 3. at 3kmc; 4. at 2.8kmc; 4. at 2.8kmc; 5. at 3.2kmc; 6. at 5kmc; 7. at highest freg.										
VARIAN ASSOCIATES, Tube Division, Palo Alto, Calif.										
X-12	refl. OSC	12.4-17.5		600						250mw
X-13	refl. OSC	8.2-12.4		500						250mw
X-13B	refl. OSC	7.5-11.0								
V-23	2-res. OSC	9.1-11.0		1350						6.5w
V-24B	ampl., 0075 du. cy.	9.0-9.6		36k						40kw
X-26	refl. OSC	5.3-7.5		750				45mc		1.2w
V-27	2-res. ampl.	9.1-11.0		1350						7w
V-27B	2-res. ampl.	8.5-10.0		1300						6w
VA-28	2-res. OSC	13.35-13.65		2950						14w
VA-39B, C	refl. OSC	10.0-15.5		650				16mc		50mw
V-40B, C	refl. OSC	15.0-21.0		700				20mc		50mw
V-42C	3-res. ampl.	0.89-0.96		18k						15wk cw
V-45	freq. mult. 1/5	9.0-10.0		1000						1.15w
V-53	refl. OSC	10.7-11.7								60mw
V-54	refl. OSC	10.5-12.2		450						225mw
X-26 B, D, E, F	refl. OSC	5.3-7.5		750						1w
V-55	refl. OSC	8.2-11.5		500						500mw
V-58	refl. OSC	8.5-10.0		500				45mc		600mw
V-63	2-res. OSC	8.5-10.0		1350						5.5w
V-67B	2-res. CW OSC	13.35-13.65		1550						1w
V-82	4-res. ampl., .025 du. cy.	9.3±9.25								7kw
V-87B, C	4-res. ampl., 002 du. cy.	2.7-2.9		90kv				±50mc.		1.3megw
VA-92	refl. OSC	14.0-17.5		600				40mc		320mw
VA-92B		12.4-14.5								
VA-92C	refl. OSC	12.4-14.5		600				40mc		600mw
VA-93	refl. OSC	13-14		300						20mw
VA-94	refl. OSC	16.0-17.0		300				65mc		40mw
VA-94B		15.8-16.2								
VA-96	refl. OSC	22.0-25.0		750				120mc		40mw
VA-97	refl. OSC	34.0-35.6		400				100mc		20mw
VA-98	refl. OSC	23.6-24.4		375				75mc		20mw
VA113, 114, 115	refl. OSC	5.92-7.72								300mw
V-151/6316	refl. OSC	8.94-9.66								25mw
V-153/6315	refl. OSC	8.5-10.0						60mc		100mw
V-152	refl. OSC	8.8-9.6		350						100mw
V-157	refl. OSC	8.5-10		385						140mw
V-154	refl. OSC	10.5-12.2		450						225mw
V-155	refl. OSC	8.8-9.6		300				55mc		55mw
VA-157	refl. OSC	8.5-10.0		385				65mc		180mw
VA-201B	refl. OSC., rug.	8.5-9.6		300				30mc		120mw
VA-203B/6975	refl. OSC., rug.	8.5-9.6		300				50mc		30mw
VA-210B	refl. OSC	9.6-10.8		300				25mc		25mw
VA-214	refl. OSC	8.0-11.2		300				35mc		35mw
VA-220A, G, Z	refl. OSC	5.92-8.1		750				35mc		1.1w

Klystrons

Type	Descr. App.	Freq. (kmc)	Heater V. A.	Beam V.	Beam A.	Refl. V.	Duty Cy.	Tun. Range	Type Out.	Pwr. Out.
VARIAN ASSOCIATES, Tube Division, Palo Alto, Calif. (cont'd.)										
VA-221B-G	refl. OSC	5.92-7.45		300				48mc		43mw
VA-221H	refl. OSC	5.25-5.56		250				35mc		40mw
VA-222A-G-Z	refl. OSC	5.92-8.1		750				35mc		1.1-2w
V-260/6310	refl. OSC	8.5-10.0		300				48mc		70mw
V-270/6312	refl. OSC	8.5-10.0		300				40mc		70mw
V-290/6314	refl. OSC	8.5-10.5		350				65mc		120mw
V262	refl. OSC	8.5-10		350						70mw
VA-800	CW ampl.	1.7-2.4		15k						10kw
VA-800C	CW ampl.	2.1-2.4		15k						10kw
VA-804 Series	4-res. ampl.	4.4-5.8		9k				± 75mc		2kw
VA-805 Series	4-res. ampl.	5.8-6.4		9k				± 25mc		2kw
VA-806 Series	4-res. ampl.	7.1-8.5		8.5k				± 25mc		2kw
VA-808	4-res. ampl. .016 du. cy.	5.3-5.9		22k				± 25mc		20kw
VA-816J	5-res. ampl.	3.4-3.5		115k						10kw
VA-820 B, C	4-res. ampl.	2.7-2.9		148k						10kw
VA-821	wide band ampl. 1004 du. cy.	2.7-3.0		90k						1-2megw
VA-833	CW ampl.	0.6-0.9		16k						10kw
VA-6237 to 6242	TV-ampl. (in 6 steps)	.47-.89		17k						15kw
6311	CW OSC	8.5-10		350						125mw
VA-87B	4-res. ampl.	2.7-2.8		110k						1.3megw
VA-87C	4-res. ampl.	2.8-2.9		Same						
VA-804A-E	4-res. ampl.	4.4-5.1		10k						2kw

Planar Triodes and Tetrodes

Type	Descr. App.	Freq. (kmc)	Heater V. A.	Anode V.	Anode MA.	Grid Bias	Duty Cy.	Ampl. Fact.	Max. Diss.	Pwr. Out.
AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y.										
EC55	ampl. OSC	3	6.3, 0.4	350	40		cw			0.5w
EC157	ampl.	4	6.3, 0.73	200	60		cw			1.8w
7377	ampl./OSC, twin. tetr.	1	6.3[1], 0.6	400	90		cw			7w
5894	ampl./OSC, twin. tetr.	0.5	6.3[1], 1.8	750	220		cw			85w
6939	ampl./OSC.ttwin. tetr.	0.5	6.3[1], 0.6	250	90		cw			5.8w
6252	ampl./OSC. twin. tetr.	0.6	6.3[1], 1.3	600	160		cw			20w
6907	ampl./OSC. twin. tetr.	0.6	6.3[1], 1.3	600	160		cw			20w
7004	ampl./OSC. triode	0.9	3.4, 19	1.3k	400		cw			160w
TBL2/400	ampl./OSC. triode	0.9	3.4, 19	2k	400		cw			330w
TBL2/500	ampl./OSC triode	1	3.4, 19	2.2k	400					450w
1. also 12.6v										
BRITISH INDUSTRIES CORP., 80 Shore Road, Port Washington, N. Y. (Representing General Electric Co., Ltd.)										
A2521	triode	1	6.3, 0.37	250	20			60	2.5w	
A2244	triode	3	6.3, 0.4	350	150			30	10w	1w
A2327	triode	3	6.3, 0.4	350	150			30	10w	1w
CV2204	triode	3	6.3, 0.4	350	150			30	10w	1w
DET22	triode	3	6.3, 0.4	350	150			30	10w	4w (1kmc)
DET29	triode	6	6.3, 0.5	450	120			55	10w	1.7w(4kmc)
DET24	triode	2	6.3, 1	400	600			33	20w	10w(1kmc)
ACT22	triode	1	6.3, 4	600	1.5a			22	75w	90w(0.5kmc)
ACT25	triode	1	13.5, 2.8	1000	5a			75	400w	300w(0.5kmc)
ACT27	triode	0.6	15, 6.7	1500	10a			45	1500w	1kw(0.35kmc)
EITEL-McCULLOUGH, INC., 301 Industrial Way, San Carlos, Calif.										
2C39A	triode	2.5	6.3, 1	1k	125	-20	cw		100	27w
2C39WA	triode	2.5	6.3, 1	1k	125	-20	cw		100	27w
3CPN10A5	triode	2.5	6, 1				plse		10	
3CX100A5	triode	2.5	6, 1	1k	125	-20	cw		100	27w
3X100A5	triode	2.5	6.3, 1	1k	125	-20	cw		100	27w
4CN15A	tetrode	1.5	6, 3	3k			plse		15	
4CX250M	tetrode	1.5	26.5, 0.57	7k		-250	plse		250	17kw
4X150G	tetrode	1.5	2.5, 6.8	7k		-250	plse		150	17kw
L. M. ERICSSON, Stockhom 20, Sweden (State Labs, Inc., 649 Broadway, New York 12, N. Y.										
416B	triode ampl., mixer, OSC noise fact: 5db @ 500mc.	0.2-4.0	6.3, 1.2	200	30	8	cw			.54 (4kmc)

Planar Triodes and Tetrodes

Type	Descr. App.	Freq. (kmc)	Heater V. A.	Anode V.	Anode MA.	Grid Bias	Duty Cy.	Ampl. Fact.	Max Diss.	Pwr. Out.
GENERAL ELECTRIC COMPANY, Electronic Components Div., One Riber Road, Schenectady 5, N. Y.										
GL-2C39-B	triode OSC, ampl.	2.5	6.3, 1.0	900	90	-150	cw	100	100w	17w
GL-2C40	triode OSC, ampl.	3.37	6.3, 0.75	500	25	-50	cw	44	6.5w	.075w
GL-2C40A	triode OSC, ampl., plsd. OSC.	3.37	6.3, 0.75	500	25	-50		44	6.5w	0.75w
GL-2C43	triode ampl, plsd OSC	3.37	6.3, 0.9	500	32	-50		70	12w	
GL-6299	triode ampl, low noise	3.0	6.6, 0.32	200	12			140	2w	
GL-6442	triode ampl, OSC, plsd OSC.	5.0	6.3, 0.9	350	35	-50		65	6w	
GL-6771	triode ampl, OSC, mult.	4.0	6.3, 0.57	300	25	-25	cw	90	6.25w	
GL-6897	triode ampl, OSC, mult.	2.9	6.3, 1.05	1k	125	-150	cw	100	100w	17w
Z-5033	triode OSC	1.0	5.75, .855	350	35		cw	55	12w	
Z-5139	triode OSC	5.0	6.3, 0.38	200	12		cw	61	2w	250mw
Z-5317	triode plsd/cw OSC, ampl.	2.5-5.0	6.3, 0.9	350	35	-50		65	8w	
GL-6283	tetrode ampl, OSC	0.9	6.8,	1.6k	300	-100	cw	10	300w	154w
GL-6942	tetrode ampl, OSC	0.9	6.0, 26.0	3.5k	350	-120	cw	22	1.5kw	1kw
Z-5049	tetrode ampl, OSC	0.8	7.0, 14.5	7.0k	1.0a	-120	cw		2kw	
Z-5102	tetrode ampl, OSC	0.8	7.0, 14.5	7.0k	1.0a	-120	cw		3.5kw	
Z-5372	tetrode plsd, ampl, OSC	0.5	6.3, 5.6	10k	10a	-175	.0012		100w	
MULLARD OVERSEAS LIMITED, Mullard House, Torrington Place, London, W.C.1										
EC157	pulse oper.	4	6.3, 0.65	300	70				10w	1.8w
TD03-5	pulse oper.	2	6.3, 0.4	350	25				5w	
TD03-10	pulse oper.	3	6.3, 0.4	350	50				10w	2.8wp
TD03-10F	pulse oper.	3	6.3, 0.4	350	50				10w	2.8wp
TD04-20	pulse oper.	2	6.3, 1	400	150				20w	18w
TDI-00A(2C39A)	pulse oper.	2.5	6.3, 1	1k	125				100w	27w
TD2-300A	pulse oper.	0.9	3.4, 19	2.5k	520				300w	475w
TD2-400A	pulse oper.	0.9	3.4, 19	2.2k	520				400w	510w
TD4. 5-10	pulse oper.	1.75	6.3, 2	4.5kp	4kp				10w	5500wp
SYLVANIA, Special Tube Operations, 500 Evelyn Ave., Mountain View, Calif.										
2C36	pulse mod. OSC	3.0		1.2kpk	900pk			25	5w	200w
2C37	CW OSC	3.3		200	25			25	5w	450mw
5764	CW/pulse OSC	3.3		200	25			25	5w	450mw
5765	CW OSC	0.9-2.9		180	25			25	5w	250mw
5767	CW OSC	3.3		200	25			25	5w	450mw
5768	CW ampl., mult.	3.0		150	7			90	2w	
6018	pulse mod. OSC	1.75		1kpk	900pk			25	5w	200w
6481	CW OSC	3.3		80	16.5			25	5w	500mw
6503	CW ampl.	3.0		200	25			23	5w	450mw

Traveling Wave Tubes

Type	Descr. App.	Freq. (kmc)	Heater V. A.	Helix V.	Focus Field (Gauss)	Gain (db)	Noise Fig. (db)	Duty Cy.	Type Out.	Pwr. Out.
AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L. I., N. Y.										
1EO	ampl.	4.4-5	6.3, 0.8	1.1k	600	34			Wg	3.5w
2EO	ampl.	3.8-4.2	6.3, 0.8	1.1k	600	37			Wg	5w
BENDIX AVIATION CORP., Red Bank Div., Eatontown, N. J.										
RXB103401	cw ampl.	4-8		1.1k		40	30		Co	200mw
BOMAC LABORATORIES, Salem Road, Beverly, Mass.										
6651	CW ampl.	2.1-3.5				41	30		Co	1kw
BL851	CW ampl.	2.1-3.5				41				1kw
BRITISH INDUSTRIES CORP., 80 Shore Road, Port Washington, N. Y. (Repr. General Electric Co., Ltd)										
TWS1	conv. cooled C, W, Amp	1.5, 3		2.2k	600[1]	40				35w
TWS2	low noise amp.	1.6-2.6		0.55k	400[1]	25	7, 9			3mw
TWS3	low noise amp.	2.7-4.1		0.55k	500[1]	25	7, 10			3.mw
TWS4	conv. cooled	5-8.2		2.5k	600[1]	40				2w
CANADIAN MARCONI CO., 2442 Trenton Ave., Montreal 16, Quebec, Canada										
N-1001	ampl.	1.7-2.3	6.3, 1.6	2.8k	400	25			Co/Wg	16w

1. Oersted

Traveling Wave Tubes

Type	Descr. App.	Freq. (kmc)	Heater V. A.	Helix. V.	Focus Field (Gauss)	Gain (db)	Noise Fig. (db)	Duty Cy.	Type Out.	Pwr. Out.
EITEL-McCULLOUGH, INC., 3001 Industrial Way, San Carlos, Calif.										
X686	rugg.	4-7				50				1w
X620	rugg., liq. cooled	4-7				30		cw		100w
ENGLISH ELECTRIC VALVE CO., LTD., Chelmsford, England										
6861	ampl.	2.7-3.5	5,0.5	375	525	25	6.5	cw	Co	1mw
N-1001	ampl.	1.7-2.3	6.3, 1.6	2630	500	25		cw	Wg/Co	16w
N-1002	ampl.	1.7-2.3	6.3, 0.3	565	450/150	23	9	cw	Wg/Co	1mw
N-1004	ampl.	3.8-4.2	6.3, 0.6	2350	550	24		cw	Wg	4w
N-1005M	ampl.	3.6-4.2	6.3, 0.3	350	400	20	9	cw	Co	1mw
N-1013	ampl.	1.7-2.3	6.3, 0.3	650	400	30	20	cw	Wg/Co	200mw
N-1016M	ampl.	4.1-7	6.3, 0.3	600	450	25	9	cw	Co	1mw
N-1017M	ampl.	1.2-1.4	6.3, 0.3	275	450/100	23	8	cw	Co	0.3mw
N-1018M	ampl.	3.6-4.2	6.3, 0.3	650	400	28	21	cw	Co	100mw
N-1029	ampl.	5.8-8.2	6.3, 0.6	2.5k	600	40		cw	Wg	8w
N-1024M	(bent version of N-1005M)								Co bent	
N-1025M	(bent version of N-1018M)								Co bent	
N-1030M	ampl.	2.7-3.5	5, 0.5	375	525	25	8.5	cw	Co	1mw
N-1031	ampl.	3.8-4.2	6.3, 0.36	500	550	25	8.5	cw	Wg	2mw
N-1032	ampl.	3.8-4.2	6.3, 0.36	1.45k	550	38	19	cw	Wg	300mw
N-1033	ampl.	3.8-4.8	6.3, 0.68	2.25k	550	38	28	cw	Wg	7w
FEDERAL TELEPHONE & RADIO CO., 100 Kingsland Rd., Clifton, N. J.										
6997	ampl., du. cy. .01	2-3.3								30w
6658	ampl., CW	1.7-4								2w
6868	ampl., CW	1.7-4								10w
6825	ampl., du. cy. .01	2-4								1000w
6826, -A	ampl., du. cy. .01	2-4								1000w
6867	ampl., CW	8-9.6								100mw
6996	ampl., CW	8-9.6								10w
D-92	ampl.,	8.5-9.6								1kw
D-95	ampl., gridded	8.5-9.6								1kw
GEISLER LABORATORIES, P. O. Box 252, Menlo Park, Calif.										
G10	ampl.	2-4								10mw
G12	low noise ampl.	2-4								10mw
G100	ampl.	2-4								10mw
G100P	ampl.	2-4								10mw
G120	low noise ampl.	2-4								10mw
G11		2-4								1w
G110		2-4								1w
G20, G200P	ampl.	4-8								10mw
G200	low noise ampl.	4-8								10mw
G21, G210P	ampl.	4-8								1mw
G40, G400P	ampl.	8.2-12.4								100mw
G41, G410	ampl.	8.2-12.4								1w
GENERAL ELECTRIC COMPANY, Electronic Components Div., One River Road, Schenectady 5, N. Y.										
Z-3028	ampl.	4-8	6.3, 0.3	460	600	25	<10		Co	1mw
Z-3031	ampl.	14-18	6, 0.2	1000	800	25	13		Wg	1mw
Z-5257	ampl.	8.5-9.6	3.5, 4.0	15kv	1500	30			Wg	2kwpk
Z-5260	ampl.	8.5-9.6	6.3, 9.0	90kv	2000	21			Wg	250kwpk
Z-3036	ampl.	7-11	6, 0.2	700	500	35	<15			3mw
Z-3040	ampl.	35-40	6, 0.2	260		25	15			1mw
Z-3068	ampl.	S-Band	12, 10		1000	30		.001		5mw
Z-5117	ampl.	2-4	20, 10		1000	27		.001		1-2mw
Z-5161	ampl.	7.5-11.3	12, 3.5	200	pm	20				
Z-5259	ampl.	8-12	6.3, 0.3	850	530	25	<10			1mw
HUGGINS LABORATORIES, INC., 999 E. Arques Ave., Sunnyvale, Calif.										
HA-1	ampl., grid.	2-4	6.3, 0.8	525	300	30	25		Co	19mw
HA-2	ampl., grid.	2-4	7, 0.9	1.1k	600	30			Co	1w
HA-4	ampl., grid.	8-12.4	7, 1.2	1.3k	400	30			Co	10mw
HA-5	ampl., grid.	1-2	6.3, 0.5	220	400	30			Co	10mw
HA-6	ampl., grid.	4-8	7, 1.3	1.5k	1.1k	30			Co	0.5w
HA-7	ampl., grid.	0.5-1	6.3, 1.4	120	300	30			Co	10mw
HA-9	ampl., grid.	8-11	6.3, 1.2	2.4k	1k	27			Co	0.5w
HA-10	ampl.	8.2-12.4	7, 1.1	2.3k	1k	20			Co	20mw
HA-11	ampl., grid.	2-4	6.3, 0.8	500	550	25	15		Co	5mw
HA-14	ampl., grid.	1-2	6.3, 0.7	190	1k	25	11		Co	
HA-16	ampl., mult.	1.8-9	7, 0.9	1.1k	600	10			Co	10mw
HA-17	ampl., grid.	1-2	6.3, 0.7	200	1k	25	15		Co	5mw
HA-18	ampl., grid.	1-2	7, 1.3	700	820	27			Co	30mw

HUGGINS LABORATORIES, INC., 999 E. Arques Ave., Sunnyvale, Calif. (cont'd.)

Type	Descr. App.	Freq. (kmc)	Heater V. A.	Helix. V.	Focus Field (Gauss)	Gain (db)	Noise Fig. (db)	Duty Cy.	Type Out.	Pwr. Out.
HA-19	ampl., grid.	1.6-2.6	6.3, 0.65	200	1k	25	15		Co	5mw
HA-20	ampl.	8-11	6.3, 1.2	1.3k	pm	30			Co	10mw
HA-21	ampl., grid.	8-11	6.3, 1.2	2.4k	pm	27			Co	27mw
HA-22	ampl.	1.6-2.6	6.3, 0.7	500	300	30			Co	10mw
HA-23	ampl., grid.	8.2-11	6.3, 0.85	1.3k	900	25	10		Co	
HA-24	ampl., grid.	12.4-15	6.3, 0.9	1.25k	400	30			Co	7mw
HA-26	ampl., grid.	4-8	7, 0.85	800	400	30			Co	10mw
HA-28	ampl., grid.	4-8	7, 0.75	800	pm	30			Co	10mw
HA-29	ampl., grid.	2-4	6.3, 0.8	525	pm	30	25		Co	10mw
HA-30	ampl., grid.	2-4	7, 0.9	1.1k	pm	30			Co	30mw
HA-31	ampl., grid.	1-2	6.3, 0.5	220	pm	30			Co	10mw
HA-33	ampl.	8-14	7, 1.2	1.3k	900	25	15		Co	
HA-34	freq. mult.	1/4	6.3, 0.75	550	550				Co	10mw
HA-35	ampl., grid.	4-8	7, 1.2	1.5k	pm	27			Co	0.5w
HA-36	ampl., grid.	0.5-1	6.3, 1.2	220	pm	30				10mw
HA-37	ampl., grid.	2-4	6.3, 0.9	500	750	25	11		Co	
HA-40	ampl., grid.	0.5-1	6.3, 0.85	130	800	25	15		Co	
HA-44	ampl., grid.	8.2-12.4	7, 1.2	1.6k	1k	25	15		Co	5mw
HA-45	ampl., grid.	0.5-1	7.5, 1	120	1.1k	25	10		Co	
HA-49	ampl., grid.	12-18	7, 1.5	1.3k	pm	20			Wg	10mw
PA-1	plsd. ampl.	8-11	6.3, 1.5	2.6k	1k	28		.03	Co	1w
PA-3	plsd. ampl.	2-4	7,1	1.1k	1k	30		0.1	Co	10wp
PA-4	plsd. ampl.	2-4	7,1	950	600	33		0.1	Co	1wp
DH-1	volt. tun. ampl.	2-4	6.3, 0.75	2.28k	100	28			Co	
DH-2	volt. tun. ampl.	1-2	6.3, 0.75	920	100	33			Co	
DH-3	volt. tun. ampl.	0.5-1	6.3, 0.75	1k	100	33			Co	
DA-4	disp. ampl.	4-8	7, 0.7	2.4k	400	25			Co	

HUGHES PRODUCTS, International Airport Station, Los Angeles 45, Calif.

Type	Descr. App.	Freq. (kmc)	Heater V. A.	Helix. V.	Focus Field (Gauss)	Gain (db)	Noise Fig. (db)	Duty Cy.	Type Out.	Pwr. Out.
MAS-1D	ampl.	2-4	6.5	7k		30		.005		1kwp

LITTON INDUSTRIES, Electron Tube Division, 960 Industrial Road, San Carlos, Calif.

Type	Descr. App.	Freq. (kmc)	Heater V. A.	Helix. V.	Focus Field (Gauss)	Gain (db)	Noise Fig. (db)	Duty Cy.	Type Out.	Pwr. Out.
L3266	military	7-11			pm			cw		10mw
L3236	airborne	7-11			pm			cw		2w

MENLO PARK ENGINEERING, 711 Hamilton Ave., Menlo Park, Calif.

Type	Descr. App.	Freq. (kmc)	Heater V. A.	Helix. V.	Focus Field (Gauss)	Gain (db)	Noise Fig. (db)	Duty Cy.	Type Out.	Pwr. Out.
TA-1	ampl.	2-4				30	25	1	N	10mw
TA-1P	ampl.	8.2-11				30	30	0.1	N	1w
TA-2	ampl.	2-4				30	30	1	N	1w
TA-4	ampl.	8.2-12.4				30	25	1	N	10mw
TA-4P	ampl.	2-4				30	30	0.1	N	1w
TA-5	ampl.	1-2				30	25	1	N	10mw
TA-6	ampl.	4-8				30	30	1	N	0.5w
TA-7	ampl.	0.5-1				30	25	1	N	10mw
TA-7P	ampl.	4-8				30	30	0.1	N	1w
TA-8	ampl.	0.5-1				30	30	1	N	1w
TA-9	ampl.	8.2-11				30	30	1	N	0.5w
TA-10	ampl.	8.2-12.4				30	30	1	N	100mw
TA-11	ampl.	2-4				25	15	1	N	1mw
TA-14	ampl.	1-2				25	10	1	N	1mw
TA-16	freq. mult.	s, x						1	N	
TA-17	ampl.	1-2				25	15	1	N	1mw
TA-18	ampl.	1-2				30	30	1	N	1w
TA-23	ampl.	8.2-11				25	11	1	N	1mw
TA-24	ampl.	12.4-15				30	25	1	Wg	10mw
TA-25	ampl.	12-18				25	25	1	Wg	2mw
TA-26	ampl.	4-8				30	25	1	N	10mw
TA-32	ampl.	4-8				25	15	1	N	1mw
TA-34	freq. mult.	UHF, S						1	N	
TA-37	ampl.	2-4				25	11	1	N	1mw
TA-40	ampl.	0.5-1				25	15	1	N	1mw
TA-43	ampl.	12-18				25	17	1	Wg	1mw
TA-44	ampl.	8.2-12.4				25	15	1	N	1mw
TA-45	ampl.	0.5-1				25	10	1	N	1mw
TA-47	ampl.	4-8				25	10	1	N	1mw
TA-6861	ampl.	2.7-3.5				25	6.5	1	N	1mw
TA-20	ampl.	8.2-11				30	25	cw	N	10mw
TA-21	ampl.	8-11				30	30	cw	N	1w
TA-28	ampl.	4-8				30	25	cw	N	10mw
TA-29	ampl.	2-4				30	25	cw	N	10mw
TA-30	ampl.	2-4				30	30	cw	N	1w
TA-31	ampl.	1-2				30	25	cw	N	10mw
TA-35	ampl.	4-8				30	30	cw	N	1w

Type	Descr. App.	Freq. (kmc)	Heater V.A.	Helix V.	Focus Field (Gauss)	Gain (db)	Noise Fig. (db)	Duty Cy.	Type Out.	Pwr. Out.
MENLO PARK ENGINEERING, 711 Hamilton Ave., Menlo Park, Calif. (cont'd).										
TA-36	ampl.	0.5-1				30	25	cw	N	10mw
TA-49	ampl.	10-16				30	25	cw	Wg	1mw
TA-6P	ampl.	2-4				30	30	0.1	N	1w
TA-8P	ampl.	4-8				30	30	0.1	N	1w
TA-51	ampl.	0.25-5				30	25	cw	N	10mw
MULLARD OVERSEAS LIMITED, Mullard House, Torrington Place, London, W.C.1										
LA4-2		3.6-4.2	6.3, 0.4	540		28	8		Wg	2mw
LA4-250		3.6-4.2	6.3, 0.75	1.5k		31	24		Wg	0.2w
LA6-3		5.9-7.1	6.3, 0.4	750		28	7.5		Wg	3mw
LA6-200		5.9-7.1	6.3, 1	1.25k		28	2.4		Wg	0.2w
LA9-3		7.0-11.5	6.3, 0.5	1.4k		27	18		Wg	6mw
LA16-2		11.5-18	6.3, 0.4	1.75k		20	20		Wg	3mw
LB4-2		3.6-4.2	6.3, 1	1.1k		35	30		Wg	2.5w
LB6-12		5.9-7.1	6.3, 1	2.4k		38	30		Wg	12w
RADIO CORPORATION OF AMERICA, Electron Tube Division, Harrison, N. J.										
A-1139	ampl.	1-2		330	sol.	25	10		Co	5mw
A-1171	ampl.	1-2		320	ppm	32	15		Co	10mw
A-1121	ampl.	1-2		560	ppm	27			Co	150mw
A-1178A	ampl.	1-2		800	ppm	30			Co	1w
A-1056	ampl.	1.1-1.4		175	400	25	7.5		Co	1mw
A-119	ampl.	2-4		420	sol.	25	10		Co	5mw
4009	ampl.	2-4		600	ppm	35	30		Co	10mw
A-1173	ampl.	2-4		475	ppm	35	15		Co	15mw
4010	ampl.	2-4		1.1k	ppm	35	30		Co	1w
A-1166	ampl.	2-4		2.1k	ppm	25			Co	10w
A-1160	ampl.	2-4		2.1k	ppm	35			Co	15w
A-1179	ampl.	2-4		3.7k	ppm	25			Co	100w
A-1097	ampl.	2-3.5		800	est.	25	30		Co	3w
A-1105	ampl.	2.19-2.31		375	525	20	7		Co	1mw
A-1113A	ampl.	2.5-3.5		600	ppm	40			Co	100mw
A-1079	ampl.	2.5-4		375	525	20	7.5		Co	1mw
6861	ampl.	2.7-3.5		375	525	25	6.5		Co	1mw
A-1085	ampl.	3.3-3.7		375	525	25	6.5		Co	1mw
A-1088	ampl.	3.5-4.3		375	525	20	8		Co	1mw
A-1174	ampl.	4-7		830	ppm	35	16		Co	10mw
A-1129	ampl.	4-5.5		1.6k	ppm	30			Co	1w
A-1136	ampl.	5-6		4.4k	ppm	35			Co	50w
A-1181	ampl.	5-11.2		6.5k	ppm	35			Wg	50w
A-1140	ampl.	8-12		1.6k	ppm	40			Wg	10mw
A-1133	ampl.	8-12		2.85k	ppm	35			Wg	1w
RAYTHEON MANUFACTURING COMPANY, Microwave and Power Tube Operations, Waltham, Mass.										
QK542	ampl.	5.9-7.4	6.3, 1	1.8k	pm	35		cw	Wg	5w
QK622	"amplitron"	2.9-3.1				12				3megw
QK783	"amplitron"	2.7-2.9				12				3megw
QK-653	"amplitron"	1.28-1.35		94k		10				5megw
ROGER WHITE ELECTRON DEVICES, INC., (No longer in existence. Purchased with all manufacturing rights by Litton Industires. Electron Tube Div., San Carlos, Calif.)										
TCC1M	low noise ampl.	4-6		600		30				1mw
TCL1M	ampl.	1-2		300		25				1mw
TCP1W	ampl.	.7-1.2		700		25				1w
TCL1W	ampl.	1-2		600		25				1w
TCS1M	ampl.	2-4		400		30				1mw
TCS1W	ampl.	2-4		1000		25				1w
TCC1W	ampl.	4-6		2000		25				1w
SPERRY GYROSCOPE COMPANY, Great Neck, N.Y.										
STL-111	CW ampl.	1.1-1.6								4w
STL-114	ampl., du. cy. .01	1.1-1.6								7000w
STL-132	CW ampl.	0.5-1.01								3w
STS-75	CW ampl.	2-4								1w
STS-110	ampl.	2-4								20w
STS-113	ampl., du. cyl .01	2.0-3.6								2000w
STS-67	CW ampl.	2.5-5.0								0.6w
STX-76	CW ampl., gridded	7-11								0.5w
STX-77	CW ampl., gridded	7-11								10w
STL-70	ampl., gridded	1-2								2w
STS-78	ampl., gridded	2-4								1w
STP-49	ampl.	.24-.51								200w
STL-48	ampl.	.5-1								200w

Traveling Wave Tubes

Type	Descr. App.	Freq. (kmc)	Heater V. A.	Helix V.	Focus Field (Gauss)	Gain (db)	Noise Fig. (db)	Duty Cy.	Type Out.	Pwr. Out.
SYLVANIA, Special Tube Operations, 500 Evelyn Ave., Mountain View, Calif.										
TW-4006	ampl.	1-2	6.3, 0.96	250	pm	40[1]		cw/plsd		15mw
TW-4007	ampl.	1-2		600	pm	30[2]		cw		1w
6753	ampl.	1-2		250		40[1]		cw/plsd		15mw
6752	ampl.	1-2		600		33[2]		cw		2w
TW-620A	ampl.	1-2		600		33[2]		cw/plsd		2w
TW-538	ampl.	1-2		8k		27[2]		plsd		1kwpk
TW-4002	ampl.	2-4	6.3, 1.5	450	pm	43[1]		cw/plsd		10mw
7072	ampl.	2-4		825	pm	30[2]		cw		1w
6493	ampl.	2-4		450		40[1]		cw/plsd		10mw
6559	ampl.	2-4		825		33[2]		cw		2w
TW-534	ampl.	2-4		825		33[2]		plsd		2wpk
6698	ampl.	2-4		8k		27[2]		plsd		1.0kwpk
TW-613	ampl.	8-11		1.15k		40[1]		cw/plsd		5mw
TW-591	ampl.	8-10.5		8k		26[2]		plsd		1.0kwpk
(notes): 1. Small sig. gain; 2. Large sig. gain.										
VARIAN ASSOCIATES, Tube Division, Palo Alto, Calif.										
VA-121B	ampl.	2-4		2.25k		30		.01		40w
VA-125	ampl.	2.7-3		110k		33			Wg	1megw

Backward Wave Tubes

Type	Descr. App.	Freq. (kmc)	Heater V.A.	Helix V.	Focus Field (Gauss)	Gain (db)	Noise Fig. (db)	Duty Cy.	Type Out.	Pwr. Out.
BENDIX AVIATION CORP., Red Bank Div., Eatontown, N. J.										
TE57	OSC	49-59		3k					Wg	5mw
TE66	OSC	46-56								
TE67	OSC	46-56								
HUGGINS LABORATORIES, INC., 999 E. Arques Ave., Sunnyvale, Calif.										
BA-1	ampl.	2.4-3.6	6.3, 1.45	1.5k	600	25			Co	
BA-2	ampl.	8.2-12.4	7, 0.7	2.4k	850	25			Co	
HO-1	OSC	2-4	6.3, 1.2	3.4k	800				Co	1mw
HO-3	OSC	3.75-7	7, 0.8	3.4k	800				Co	1mw
HO-4	OSC	12-18	7, 0.8	2k	1k				Wg	1mw
HO-9	OSC	1-2	7, 2	2.6k	800				Co	10mw
HO-10	OSC	3.7-5.9	7, 1.3	2k	1k				Co	1mw
HO-11	OSC	5.2-8.3	6.3, 1.4	2k	1k				Co	1mw
HO-13	OSC	4-8	6.3, 1.4	3k	1k				Co	1mw
HO-14	OSC	8.2-12.4	7, 0.8	2k	1k				Co	1mw
HO-17	OSC	7-11	6.3, 1.2	2k	1k				Co	1mw
HO-2	OSC	8.2-12.4								
HO-18	OSC	2-4								
HO-19	OSC	12-18								
HO-20	OSC	8.2-12.4								
HO-21	OSC	4-8								
HO-22	OSC	8.5-12			pm					
HUGHES PRODUCTS, International Airport Station, Los Angeles 45, Calif.										
LOU-2, B	OSC	12-18	6.3, 0.6	1.9k	pm			cw	Wg	60mw
PAS-2B	ampl.	2-4		2.75k	1k	25	4	cw	Co	1mw
PAX-1	ampl.	8.5-9.5		1.5k	1.3k	20	4.5	cw	Wg	0.2mw
LITTON INDUSTRIES, Electron Tube Division, 960 Industrial Road, San Carlos, Calif.										
L3148	carcinotron	8.5-11			pm			cw		150w
MENLO PARK ENGINEERING, 711 Hamilton Ave., Menlo Park, Calif.										
HS-1	swept OSC	2-4								10mw
HS-2	swept OSC	8.2-12.4								10mw
HS-3	swept OSC	3.7-7								1mw
HS-4	swept OSC	12.4-18								10mw
HS-5	swept OSC	0.5-1								10mw

Backward Wave Tubes

Type	Descr. App.	Freq. (kmc)	Heater V. A.	Helix V.	Focus Field (Gauss)	Gain (db)	Noise Fig. (db)	Duty Cy.	Type Out.	Pwr. Out.
MENLO PARK ENGINEERING, 711 Hamilton Ave., Menlo Park, Calif. (cont'd.)										
HS-9	swept OSC	1-2								10mw
HS-10	swept OSC	3.7-5.9								10mw
HS-11	swept OSC	5.2-8.3								10mw
HS-13	swept OSC	4-8								1mw
HS-14	swept OSC	8.2-12.4								1mw
HS-17	swept OSC	7-11								1mw
HS-18	swept OSC	2-4								1mw
HS-19	swept OSC	12-18								1mw
MULLARD OVERSEAS LIMITED, Mullard House, Torrington Place, London, W.C.1										
NA3-30	OSC	2.4, 2.7	6.3, 2.3		pm				Co	0.2w
BA9-20	OSC	7, 11.5	6.3, 1.7		pm				Wg	0.12w
BA16-10	OSC	11, 18	6.3, 1		pm				Wg	45mw
RAYTHEON MANUFACTURING COMPANY, Microwave and Power Tube Operations, Waltham, Mass.										
QK546	OSC	1-2	6.3, 3.1	14.5k						1.5w
QK544	OSC	1.6-3.2	6.3, 3.1	1.45k						1w
QK518	OSC	2-4	6.3, 1.5	1.5k						1w
QK533	OSC	2.4-4.8	6.3, 2.4	1.45k						1w
QK528	OSC	3.6-7.2	6.3, 1	1.45k						400mw
QK543	OSC	4.8-9.6	6.3, 2.1	1.45k						200mw
QK529	OSC	7-11	6.3, 2.1	1.5k						150mw
QK535	OSC	7.5-15	6.3, 2.1	1.7k						150mw
QK634	OSC, M-type	8.5-11	10, 1.7	5.2k					Wg	250w
QK625	OSC, M-type	2.5-3	10, 2	4.95k						300w
QK684	OSC	8.5-9.6		325						50mw
QK610	Tun. OSC, M-type	6.7-11.4	6.3, 1.5	1.5k						300mw
ROGER WHITE ELECTRON DEVICES, (No longer in existence. Purchased with all manufacturing rights by Litton Industries, Electron Tube Div., San Carlos, Calif.)										
BCX10M	OSC	8-12		1.5k						10mw
BWK10M, A	OSC	12-18		1.5k						5mw
STEWART ENGINEERING COMPANY, P.O. Box 277, Soquel, Calif.										
OA3.7-5.9	OSC	3.5-5.9				6			Co	50mw
OA4-8	OSC	4-8				10			Co	10mw
OA5.2-8.3	OSC	5.2-8.3				6			Co	20mw
OC6-11	OSC	6-11				6			Co	10mw
OE6-11	OSC	7-11				4			Co	50mw
OC6-12	OSC	6-12				6			Co	50mw
OE6-12	OSC	7.3-10.3				4			Co	50mw
OC7-13	OSC	8.2-12.4				3			Wg	10mw
OD7-13	OSC, gridded	8.2-12.4				3			Wg	10mw
OA10-15.5	OSC	10-15.5				3			Wg	10mw
OA12-18	OSC	12.4-18				4			Wg	5mw
SYLVANIA, Special Tube Operations, 500 Evelyn Ave., Mountain View, Calif.										
6699	OSC	1-2	6.3, 3.9	875	600			cw/plsd		700mw
6496	OSC	2-4	6.3, 2.7	1680	500			cw/plsd		700mw
BW-623	OSC	4-8	6.3, 2.4	2300	750			cw/plsd		270mw
PM-1757	OSC	26.5-41								5mw
VARIAN ASSOCIATES, Tube Division, Palo Alto, Calif.										
VA-161	OSC	8.2-12.4		650						120mw

A CONTINUING EI EDITORIAL SERIES . . .

This "Summary of Microwave Electron Devices" is presented as the latest in ELECTRONIC INDUSTRIES' series of Staff Reports on Electronic Components.

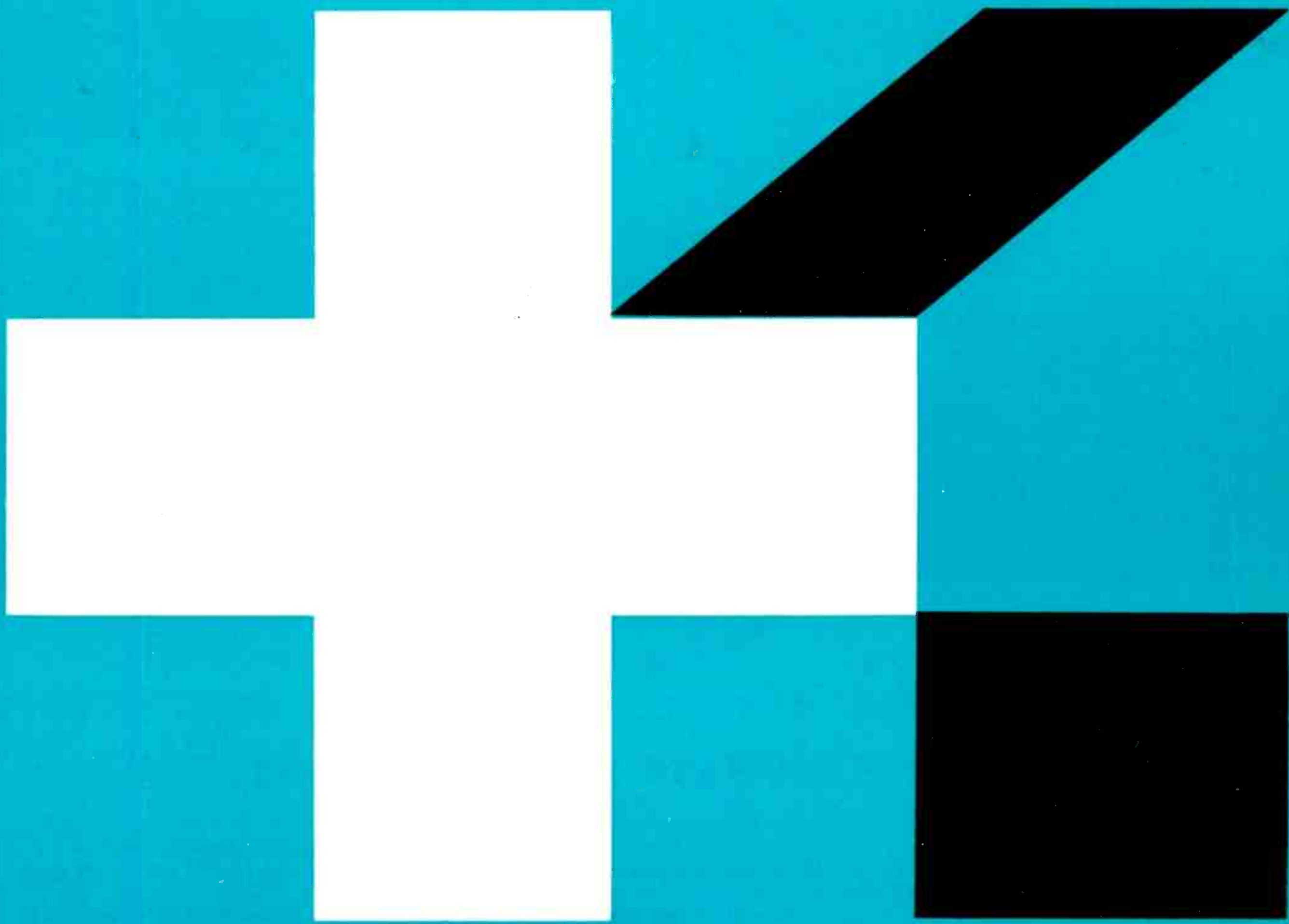
Other reports published during 1959 include:

- **1959 Transistor Interchangeability Guide**
- **1959-60 Transistor Specifications**
- **1959-60 Semiconductor Diode Specifications**
- **WIRE—For the Electronic Industry**

Electronic Industries

1960 Coming Events Calendar

Portraying important electronic events for the year ahead



KITTLESON COMPANY, manufacturers' representatives of precision electronic equipment, are pleased to present you with this 1960 Coming Events Calendar. It is hoped that you will find it useful in keeping abreast of forthcoming activities within the industry, as well as an aid toward more complete knowledge of those lines we represent.

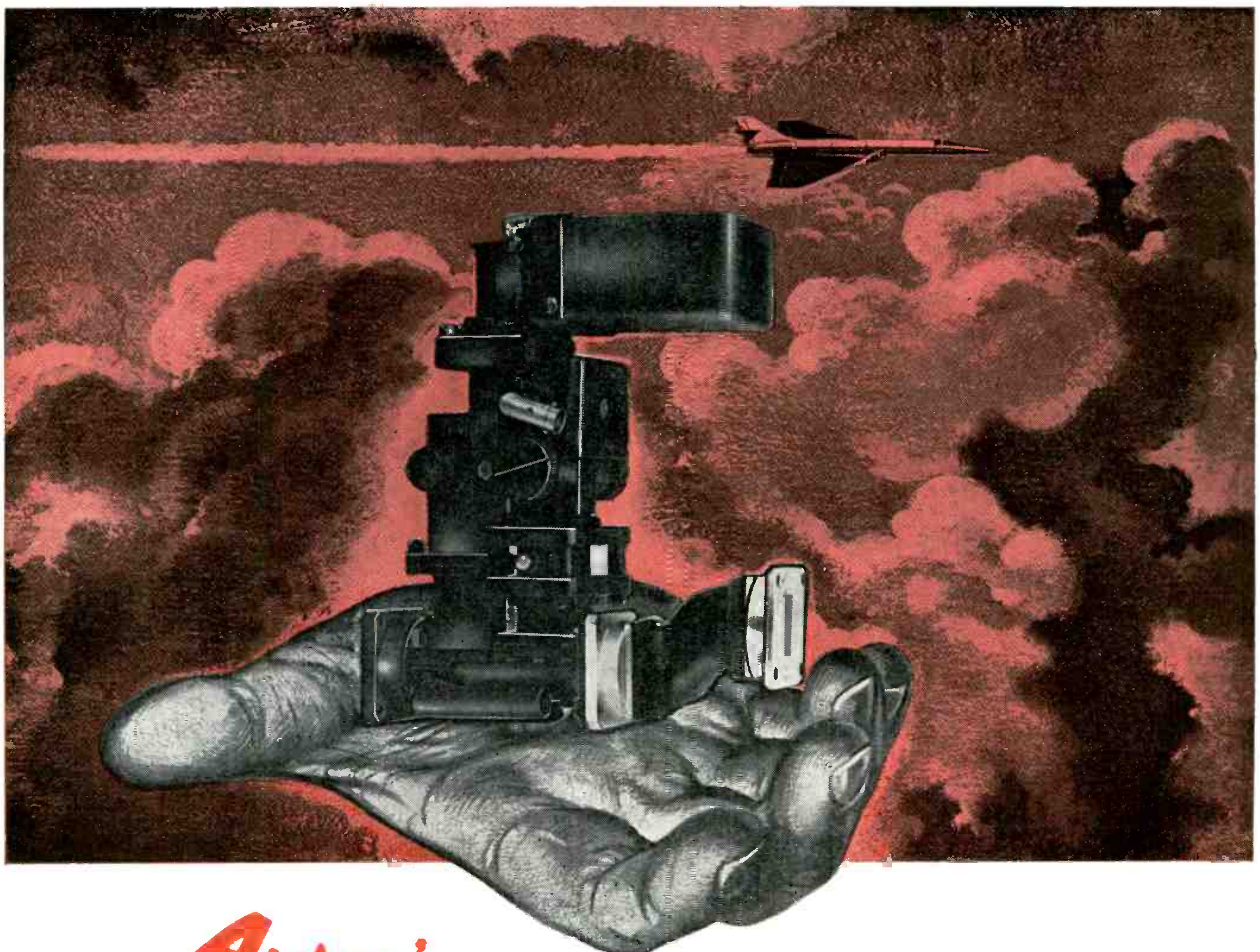
If additional copies of the Coming Events Calendar are desired please contact any one of our three offices shown below:

SO. CALIFORNIA & ARIZONA
416 No. La Brea Ave.
Los Angeles 36, Calif.
WEbster 3-7371

NO. CALIFORNIA & NEVADA
809 San Antonio Rd.
Palo Alto, Calif.
DAvenport 6-7410

NEW MEXICO
P. O. Box 803
Alamogordo, New Mexico
HEmlock 7-2780

AIRTRON, INC.,
A DIV. OF LITTON INDUSTRIES
CEDAR ENGINEERING, INC.
ELECTRONIC TUBE CORPORATION
HERMES ELECTRONICS CO.
INTERNATIONAL INSTRUMENTS, INC.
KEYSTONE ELECTRONICS COMPANY
LAVOIE LABORATORIES, INC.
LIBRASCOPE, INC.
PACKARD BELL COMPUTER CORPORATION
REMANCO, INC.
SERVO CORPORATION OF AMERICA
SPENCER-KENNEDY LABORATORIES, INC.
ULTRADYNE, INC.
U. S. SEMICONDUCTOR PRODUCTS, INC.
VALOR INSTRUMENTS, INC.



Airtron's advanced engineering departments offer tomorrow's microwave designs . . . today!

New Transmitter-Receiver Unit of the Bendix Radio RDR-1D Airborne Weather Radar System. Airtron's new Mixer-Ferrite Duplexer substantially aided Bendix Radio in designing and realizing a . . .

50% size reduction

48% input power reduction

40% weight reduction

while maintaining equal performance.

Airtron, Inc., with one of the most advanced engineering departments and manufacturing facilities in the microwave field, has recently designed, under developmental contract, a new high-performance mixer-ferrite duplexer for the new transmitter-receiver unit of the Bendix Radio RDR-1D Airborne Weather Radar System.

The difficult assignment of designing and developing this assembly similar in design to the previous one developed by Airtron was undertaken at the extensive engineering facilities of Airtron, Inc. The highly skilled engineering staffs of all of Airtron's facilities functioned as a team in developing this new ferrite rotational duplexer and low noise figure mixer assembly. Through the combined efforts of its advanced engineering teams, working closely with the skilled technical staffs of its manufacturing facilities, a new mixer-ferrite duplexer was designed, developed and perfected which gave improved performance with a considerable reduction in size and weight that met the stringent requirements set forth.

Production follows development and Airtron's extensive manufacturing facilities are fully equipped with the latest in production facilities, from compounding special ferrite materials to precision casting and dip-brazing final assemblies to meet and satisfy the needs of industry. It was Airtron, Inc. who pioneered in the development of one transmission line to carry both "C" and "X" band frequencies . . . the double-ridged waveguide, ARA-136 and produced it in production quantities.

This is just one example of the confidence industry has placed in the creative abilitiy of Airtron's exceptional engineering staff. Couple this with one of the most extensive manufacturing facilities in the microwave field and you know why Bendix Radio and other leading manufacturers and users of weather radar systems and microwave components come to Airtron, Inc., for prototype design — specify Airtron components for their microwave requirements . . . and **Look To Airtron Today For Their Microwave Designs Of Tomorrow.**

THE MASTER BUILDER OF MICROWAVE COMPONENTS

Airtron inc. A DIVISION OF LITTON INDUSTRIES

1301 E. LINDEN AVE., LINDEN, N. J. | 200 E. HANOVER AVE., MORRIS PLAINS, N. J. | 5873 RODEO RD., LOS ANGELES, CALIF.

OPPORTUNITIES AT ALL THREE LOCATIONS FOR ENGINEERS SEEKING INDIVIDUAL GROWTH.

ELECTRONIC INDUSTRIES'

1960 Coming Events Calendar

Portraying important electronic events for the year ahead

A listing of meetings, conferences, shows, etc., occurring during the year 1960 that are of special interest to electronic engineers. The events are listed chronologically and by the area—East, Midwest, and West—in which they occur. The deadline for submitting papers and whom to contact for information are given (when available) following the meeting. The opening day of each meeting is marked on the calendar.

JANUARY

East

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	**11**	**12**	13	14	15	16
17	18	**19**	**20**	21	22	23
24	**25**	**26**	**27**	28	29	30
31						

Midwest

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	**12**	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

West

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	**13**	14	15	16
17	18	19	20	21	22	**23**
24	25	**26**	27	**28**	29	30
31						

EAST

Jan. 5: Statistical Ideas Useful in Experimentation, Society for Applied Spectroscopy; New Yorker Hotel, New York.

Jan. 11-13: 6th National Symposium on Reliability & Quality Control, IRE, AIEE, ASQC, EIA, Statler-Hilton Hotel, Washington, D. C., C. M. Ryerson, RCA, Camden, N. J.

Jan. 12: Seminar—Optical Tooling Methods in Manufacturing, ASTE, Phila., Pa.

Jan. 14-20: 6th Annual Meeting, American Astronautical Society; Statler Hilton Hotel, New York, N. Y.

Jan. 19: Monthly Meeting, Radio Club of America, Ben Franklin Hall, New York, N. Y.

Jan. 20: Meeting—Automation of Electronic Assembly Pro & Con Panel of 4 Speakers, IRE (PGPT), Phila. Chapter, Auditorium (Physical Sciences) Univ. of Pennsylvania, Phila., Pa.

Jan. 25-28: 28th Annual Meeting, Inst. of the Aeronautical Sciences, Hotel Astor, New York, N. Y.

Jan. 26-27: 3rd Annual Meeting, Society of Vacuum Coaters; Hotel Biltmore, N. Y., N. Y.

Jan. 27-30: Meeting, The American Physical Society, New York, N. Y.

Jan. 28-29: Solid Propellants Conference, American Rocket Society; Princeton Univ., Princeton, N .J.

Jan. 31-Feb. 5: Winter General Meeting, AIEE, Hotel Statler, N. Y.

MIDWEST

Jan. 12: Meeting. Assoc. of Electronic Parts & Equipment Manufacturers, Inc., Chicago, Ill.

Jan. 12-15: 16th Annual Technical Conf., Society of Plastics Engineers, Inc.; Conrad Hilton Hotel, Chicago, Ill.

Jan. 20: 2nd Conf. on Flat Rolled Products. American Inst. of Metallurgical Engineers, Del Prodo Hotel, Chicago, Ill.

Jan. 24-Feb. 5: Seminar in Executive Leadership, Univ. of Arizona and Cornell; Univ. of Arizona, Tucson, Ariz.

WEST

Jan. 13-17: Los Angeles High Fidelity Music Show, Institute of High Fidelity Manufacturers; Pan Pacific Auditorium, Los Angeles, Calif.

Jan. 24-29: Western Winter Market. Western Merchandise Mart, San Francisco, Calif.

Jan. 24-29: Board of Directors Meeting. Nat'l Assoc. of Broadcasters, El Mirado Hotel, Palm Springs, Calif.

Jan. 26: Seminar—Numerical Control in Creative Mfg. American Soc. of Tool Engineers, Los Angeles, Calif.

Jan. 28-29: Seminar—What We Know Today About Metal Cutting. American Soc. of Tool Engineers, San Francisco, Calif.

Jan. 23-26 San Francisco High Fidelity Music Show; MRIH; Cow Palace, San Francisco, Calif.

Jan. 25-29: Stress Measurement Symposium, Strain Gage Readings Magazine. Arizona State Univ.

FEBRUARY

East

S	M	T	W	T	F	S
	1	**2**	3	4	5	6
7	8	9	**10**	11	12	13
14	15	**16**	17	18	19	20
21	22	23	24	**25**	26	27
28	29					

Midwest

S	M	T	W	T	F	S
	1	2	3	**4**	**5**	6
7	8	9	10	**11**	12	13
14	15	**16**	17	**18**	19	20
21	22	23	24	25	26	27
28	29					

West

S	M	T	W	T	F	S
	1	2	**3**	4	5	6
7	8	9	10	11	12	13
14	15	16	17	**18**	19	20
21	22	23	24	25	26	27
28	29					

EAST

Feb. 2-4: Instrument-Automation Conf. (Exhibits), ISA, Sam Houston Coliseum, Houston, Tex., William H. Kushnick, Exec. Dir., ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

Feb. 10-12: Solid State Circuits Conf., AIEE, IRE, Univ. of Pennsylvania, Phila., Pa., Tudor R. Finch, Bell Telephone Labs., Murray Hill, N. J.

Feb. 14-18: Annual Meeting, American Inst. of Mechanical Engineers: Hotels Sheraton-McAlpin & Statler-Hilton, New York, N.Y.

Feb. 16: Monthly Meeting, Radio Club of America, Ben Franklin Hall, New York, N. Y.

Feb. 25-26: Scintillation Counter Symposium, IRE (PGNS), AIEE, IRE, AEC, NBS, Washington, D. C., George A. Morton, RCA Labs, Princeton, N. J.

MIDWEST

Feb. 1-4: Instrument-Automation Conf. (Exhibits), Instrument Society of America; Sam Houston Coliseum, Houston, Texas.

Feb. 1-4: 2nd Southwest Heating & Air Conditioning Exposition. American Soc. of Heating, Refrigerating & Air-Conditioning Engineers, Inc., Memorial Auditorium, Dallas, Tex. R. C. Cross, 234 Fifth Ave., N. Y.

Feb. 1-5: Committee Week. American Soc. for Testing Materials, Sherman Hotel, Chicago, Ill.

Feb. 4: Seminar—Automation & Your Production Program. American Soc. of Tool Engineers, Detroit, Mich.

Feb. 5-6: Industrial Management Engineering Conf. Illinois Inst. of Technology, Illinois Institute of Technology, Chicago, Ill.

Feb. 11-12: Cleveland Electronics Conf., IRE, ISA, AIEE, Cleveland Physics Society, Case Institute of Technology, Western Reserve Univ., Engineering & Scientific Center, Cleveland, Ohio.

Feb. 11-13: Nat'l Convention. Electronic Representative Assoc., Drake Hotel, Chicago, Ill. Electronic Representative Assoc., 600 South Michigan Ave., Chicago 5, Ill.

Feb. 16: Educational Seminar. Assoc. of Electronic Parts & Equipment Manufacturers, Inc., Niles, Ill.

Feb. 18-20: Winter Meeting Nat'l Soc. of Professional Engineers, Broadview Hotel, Wichita, Kans.

WEST

Feb. 3-5: Winter Meeting. IRE (PGMIL), Biltmore Hotel, Los Angeles, Calif. Gordon B. Knoob, Motorola, Inc., Military Electronics Div., 1741 Ivar, Hollywood, Calif.

Feb. 18-21: Distributor, Representative, Manufacturer Conf. Electronic Representative Assoc., El Mirador Hotel, Palm Springs, Calif.

MARCH

East

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	**15**	16	17	18	19
20	**21**	22	**23**	24	25	26
27	28	29	30	31		

Midwest

S	M	T	W	T	F	S
		1	2	3	**4**	5
6	7	**8**	**9**	**10**	11	12
13	14	15	16	17	18	19
20	**21**	22	23	24	25	26
27	28	**29**	30	31		

West

S	M	T	W	T	F	S
		1	2	**3**	4	5
6	7	**8**	**9**	10	11	12
13	14	15	16	17	18	19
20	21	22	**23**	24	25	26
27	28	29	30	31		

EAST

Mar. 15: Monthly Meeting, Radio Club of America, Ben Franklin Hall, New York, N. Y.

Mar. 21-24: IRE National Convention, IRE (All PG's), Coliseum & Waldorf Astoria Hotel, New York, N. Y. Gordon K. Teal, Chairman, Tech. Prog. Comm., IRE Headquarters, 1 E. 79th St., New York 21, N.Y.

Mar. 23-24: Seminar-Metal Forming Methods for Tomorrow's Manufacturing, ASTE, Hartford, Conn.

MIDWEST

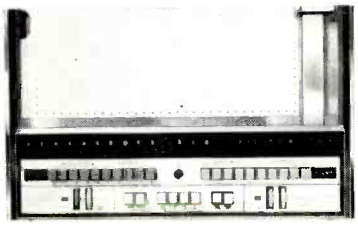
March 4-5: Meeting. The American Physical Soc., Houston, Tex.

March 6-9: Gas Turbine Power Conf. (Exhibits). American Soc. of Mechanical Engineers, Rice Hotel, Houston, Tex.

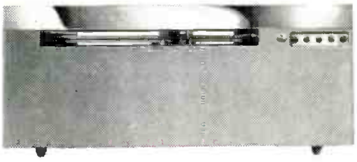
March 8: Annual Meeting. Assoc. of Electronic Parts & Equip. Manufacturers, Inc., Chicago, Ill.

March 9-11: Temperature Measurement Symp.: Instrument Soc. of America, Deshler Hilton Hotel, Columbus, Ohio. Director of Tech & Educational Services, ISA, 313 Sixth Ave., Pittsburgh, Pa.

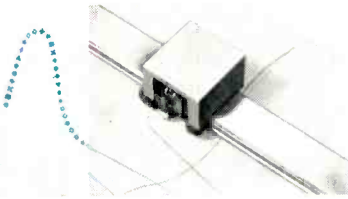
March 10-11: National Flight Propulsion Meeting (Classified). Institute of Aeronautical Sciences, Cleveland, Ohio.



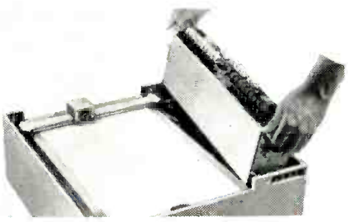
PUSH BUTTON PANEL controls operations rapidly, even at remote locations.



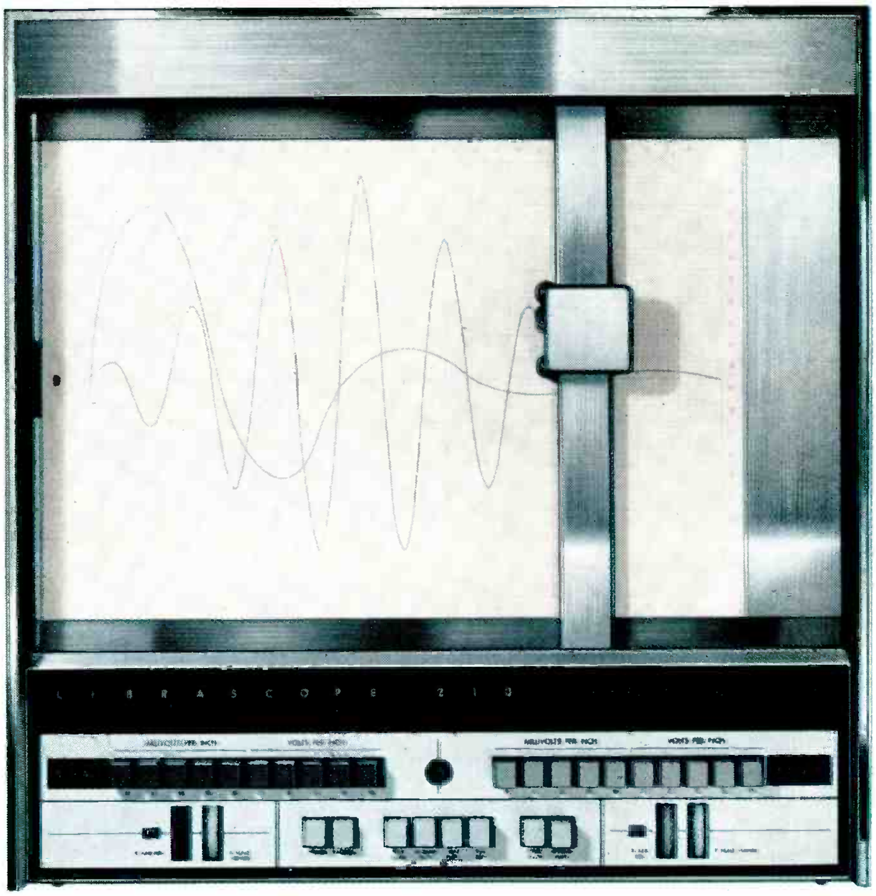
FLAT VACUUM PLATEN assures positive hold down of roll or sheet paper up to 12¼" width. Plot area, standard 10x15".



PRINTING FEATURES: Multiple symbol printing head—12 symbols...self contained ink supply.
Pen System—capillary action; splatter-proof. Point joiner available.



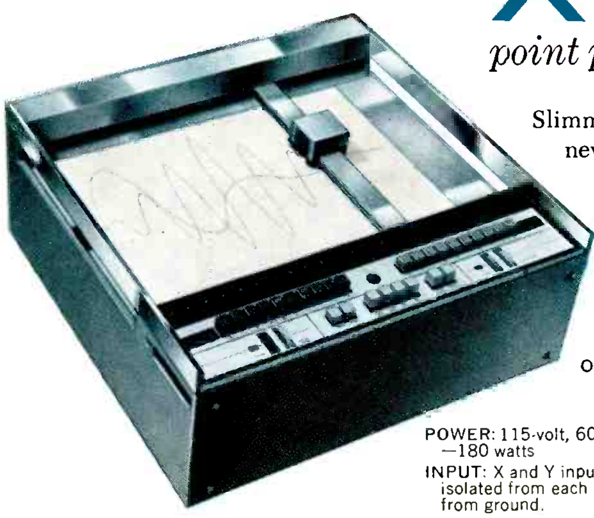
INTERCHANGEABLE MODULES add versatility...interchange with basic control section.



engineered for ease of operation...new

LIBRASCOPE X·Y PLOTTER

point plotting or continuous trace



Slimmer, flatter, push-button fast...Librascope's newest, most advanced plotter is the result of personally-conducted field research by Librascope engineers. Compact design permits rack mounting in groups, saves desk space. Many new conveniences have been added to answer *your* needs.

OPERATING INFORMATION

POWER: 115-volt, 60 cycle —180 watts
INPUT: X and Y inputs isolated from each other and from ground.
INPUT RESISTANCE: 2 megohms nominal on most scales. 1 megohm per volt on .5 millivolts per inch to .1 volts per inch scales.

INPUT SENSITIVITY: .5 millivolts per inch to 50 volts per inch with calibrated push button scales at .5, .1, 5, 10 and 50 millivolts per inch and .1, .5, 1, 5 and 10 volts per inch. Vernier controls permit continuous sensitivity adjustment between fixed scales, permitting full scale plotting for any sensitivity.
ACCURACY: Static .1%, dynamic .2% at 10" per second.
PLOTTER CALIBRATION ACCURACY: .05% on all scales.
SLEWING SPEED: 20" per second.

For full details—dimensions, applications, list of accessory equipment, call our Sales Engineering Department or send for illustrated brochure on Model 210, XY Plotter.

For information on career opportunities at Librascope, write Glen Seltzer, Employment Manager.

LI 9-20

LIBRASCOPE

A GENERAL PRECISION COMPANY

LIBRASCOPE, INC. 100 E. TUJUNGA AVE. • BURBANK, CALIFORNIA • *A Subsidiary of General Precision Equipment Corporation*

MARCH —*continued*

March 21-24: Meeting. The American Physical Soc., Detroit, Mich.

March 29-31: American Power Conf. Illinois Inst. of Technology, Hotel Sherman, Chicago, Ill.

WEST

Mar. 1-2: Seminar-Optical Tooling Methods in Mfg. American Soc. of Tool Engineers, Los Angeles, Calif.

March 3-4: Seminar—Metal Forming Methods for Tomorrow's Manufacturing. American Soc. of Tool Engineers, Los Angeles, Calif.

March 8-9: Seminar—Some Problems of Machining Space Age Metals, American Soc. of Tool Engineers, San Francisco, Calif.

March 9-11: 3rd Navy Science Symposium, "Naval Problems in Electromagnetic Radiation." Office of Naval Research, Naval Ordnance Test Sta., Pasadena, Calif.

March 23-26: 10th Biennial Electrical Industry Show & 1st Lighting Exposition. Electrical Maintenance Engineers Assoc. of Calif., Shrine Exposition Hall, Los Angeles, Calif.

APRIL

East

S	M	T	W	T	F	S
					1	2
3	**4**	**5**	6	7	8	9
10	**11**	12	13	14	15	16
17	18	**19**	**20**	**21**	22	23
24	**25**	26	27	28	29	30

Midwest

S	M	T	W	T	F	S
					1	2
3	**4**	**5**	6	7	8	9
10	11	**12**	13	14	15	16
17	**18**	**19**	**20**	**21**	22	23
24	**25**	26	**27**	28	29	30

West

S	M	T	W	T	F	S
					1	2
3	4	5	**6**	7	8	9
10	11	12	13	14	15	16
17	18	19	**20**	21	22	23
24	**25**	26	27	28	29	30

EAST

April 3-8: 6th Nuclear Congress (Exhibits), EJC, IRE (PGNS) (28 Sponsors), N. Y. Coliseum, New York, N. Y. M. E. Cassidy, USAEC, N. Y., Operations Office, 376 Hudson St., New York 14, N. Y.

April 4-7: Atomic Exposition & Nuclear Congress. 28 Sponsors incl. IRE, ISA, AIEE, ARS, ASME, IAS, New York Coliseum, N. Y. International Atomic Exposition, Architects Bldg., 117 So. 17th St., Phila. 3, Pa.

April 5-7: 3rd National Chemical & Petroleum Instrumentation Symposium. ISA, Rochester, N. Y. Director of Tech. & Educational Services, ISA, 313 Sixth Ave., Pittsburgh, Pa.

April 11-13: Spring Assembly Meeting. Radio Technical Commission for Marine Services, Washington, D. C.

April 19: Monthly Meeting. Radio Club of America, Ben Franklin Hall, N. Y.

April 19-21: International Symposium on Active Networks and Feedback Systems. Microwave Research Inst. of the Polytechnic Inst. of Brooklyn, IRE, AFOSR, U. S. Army (Sig. Corp.), Engineering Societies Bldg., 33 W. 39th St., New York, N. Y.
Prof. Herbert J. Carlin, Microwave Research Inst., 55 Johnson St., Bklyn, N. Y. (Paper Deadline - 1-15-60)

April 20: 16th Annual Quality Control Conf. Rochester Soc. for Quality Control, Univ. of Rochester, Rochester, N. Y. Raymond F. Woods, Dept. 63, Bldg. 3, Apparatus & Optical Div., Eastman Kodak Co., Rochester 4, N. Y. (Date Deadline - 3-1-60).

April 21-22: Management Conf. ASME, SAM, Statler-Hilton Hotel, New York, N. Y.

April 25-28: Meeting. The American Physical Soc., Washington, D. C.

MIDWEST

April 3-7: Annual Convention. Nat'l Assoc. of Broadcasters, Conrad Hilton Hotel, Chicago, Ill.

April 4-6: 43rd Nat'l Open Hearth Steel Conf. Metallurgical Soc. of AIME, Palmer House, Chicago, Ill.

April 4-6: Southwest District Meeting, American Inst. of Electrical Engineers, Shamrock-Hilton Hotel, Houston, Tex.

April 5: Annual Dinner Meeting. Broadcast Pioneers, Conrad Hilton Hotel, Chicago, Ill.

April 12-14: 32nd Annual Meeting (Exhibits), Petroleum Industry Electrical Assoc., Petroleum Electric Supply Assoc.; Municipal Auditorium, Kansas City, Mo. Fred Jones, 1200 Power & Light Building, Kansas City 5, Mo.

April 18-19: Conf. on Automatic Techniques. AIEE, ASME, IRE (PGIE), Sheraton Cleveland Hotel, Cleveland, Ohio. L. W. Herschenroeder, Industry Ing., Westinghouse Elec. Corp., E. Pittsburgh, Pa., or Publicity Chairman, Rm. 530, 1213 W. 3rd St., Cleveland 13, Ohio.

April 19: Joint Dinner Meeting. Assoc. of Electronic Parts & Equipment Manufacturers, Chicago, Ill.

April 20-22: S. W. IRE Regional Conf. & Electron Show (SWIRCO). Region 6, IRE, Houston, Tex. Ralph T. Dosher, Jr., Texas Instruments Incorporated, P. O. Box 6027, Houston 6, Tex. (Paper Deadline — 11-1-59).

April 21-22: 7th Annual Convention. Soc. of Technical Writers & Editors, Drake Hotel, Chicago, Ill.

April 21-22: Seminar—Dimensional Metrology, American Soc. of Tool Engineers, Detroit, Mich.

April 21-28: Tool Show & Annual Convention, American Soc. of Tool Engineers, Detroit, Mich.

April 25-26: Maintenance & Plant Engineering Show. American Soc. of Mechanical Engineers, Chase-Park Plaza, St. Louis, Mo.

April 25-27: 16th Annual Meeting. Metal Powder Assoc., Drake Hotel, Chicago, Ill. Kempton H. Roll, 130 W. 42nd St., New York, N. Y.

April 27-29: Great Lakes District Meeting. American Inst. of Electrical Engineers, Milwaukee, Wisc.

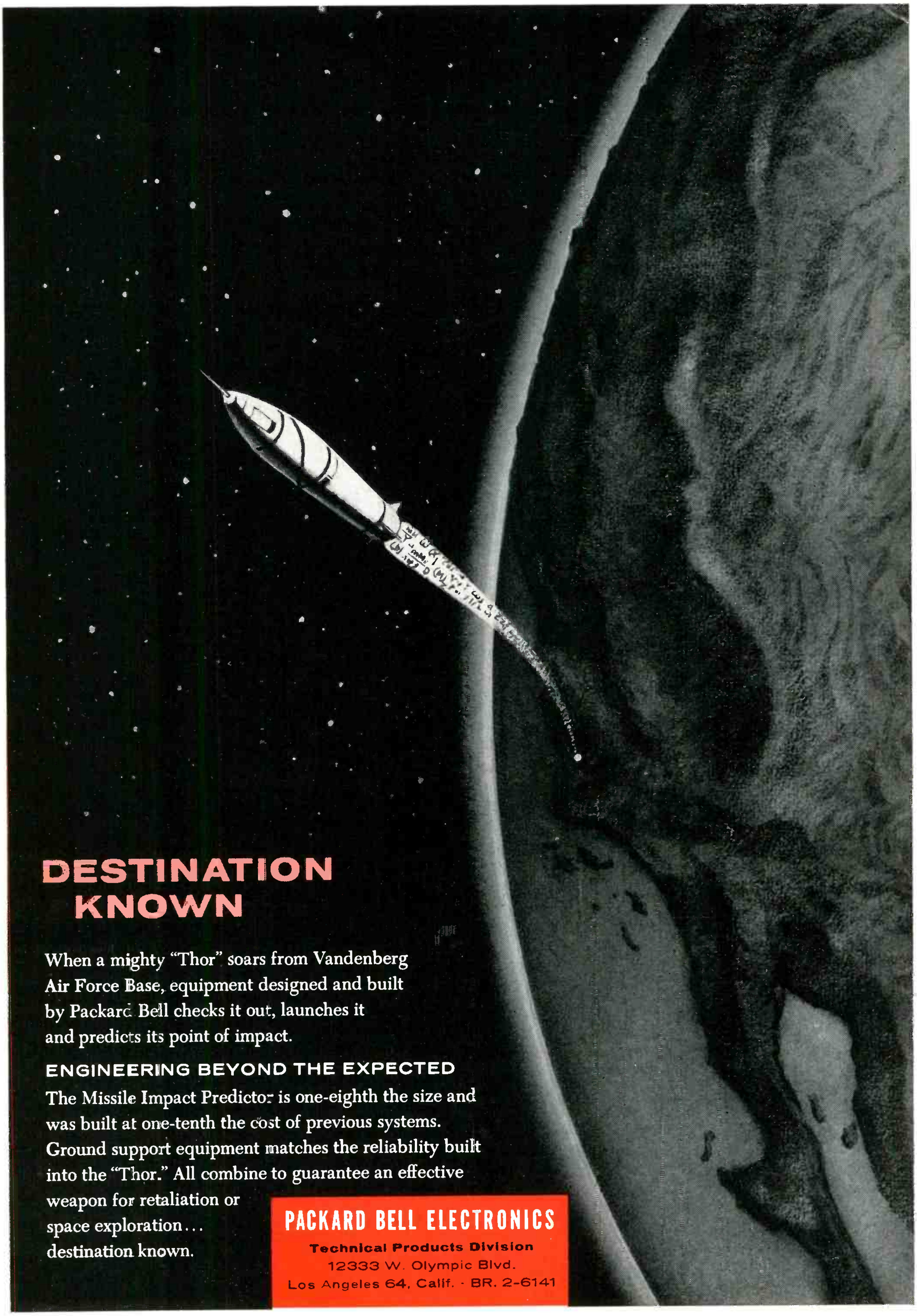
WEST

April 6-8: Nat'l Meeting (Hyper-Environments—Space Frontier). Inst. of Environmental Sciences, Biltmore Hotel, Los Angeles, Calif. Neal Grannick, 66 Waverly Ave., Dayton 5, Ohio

April 20-22: Nat'l Symposium on Manned Space Stations, Inst. of Aeronautical Sciences, Nat'l Aeronautical & Space Administration, Rand Corp., Ambassador Hotel, Los Angeles, Calif.

April 25-29: Metals Engineering Meeting, American Soc. for Mechanical Engineers, Hotel Biltmore, Los Angeles, Calif.

April 25-29: Annual Meeting & Welding Exposition. American Welding Soc., Hotel Biltmore, Los Angeles, Calif. B. E. Rossi, 33 W. 39th St., New York 18, N. Y.


DESTINATION KNOWN
When a mighty "Thor" soars from Vandenberg Air Force Base, equipment designed and built by Packard Bell checks it out, launches it and predicts its point of impact.
ENGINEERING BEYOND THE EXPECTED
The Missile Impact Predictor is one-eighth the size and was built at one-tenth the cost of previous systems. Ground support equipment matches the reliability built into the "Thor." All combine to guarantee an effective weapon for retaliation or space exploration... destination known.
PACKARD BELL ELECTRONICS
Technical Products Division
12333 W. Olympic Blvd.
Los Angeles 64, Calif. · BR. 2-6141

MAY

East

S	M	T	W	T	F	S
1	**2**	3	4	5	6	7
8	9	**10**	11	12	13	14
15	**16**	**17**	18	19	20	21
22	**23**	**24**	**25**	26	27	28
29	30	**31**				

Midwest

S	M	T	W	T	F	S
1	**2**	**3**	4	**5**	6	7
8	9	10	11	12	13	14
15	**16**	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

West

S	M	T	W	T	F	S
1	**2**	3	4	5	6	7
8	**9**	10	11	12	13	14
15	16	17	18	19	20	21
22	**23**	24	25	26	27	28
29	30	31				

EAST

May 2-4: North Eastern District Meeting. American Institute of Electrical Engineers, Providence, R. I.

May 10-12: Electronic Components Conf. IRE, AIEE, EIA, WCEMA, Washington, D. C. Gilbert B. Devey, Technical Program Chairman, Sprague Electric Co., N. Adams, Mass. (Paper Deadline—2-1-60)

May 16-19: Power Sources Symp. U. S. Army Signal Research & Development Lab., Shelburne Hotel, Atlantic City, N. J.

May 17: Monthly Meeting. Radio Club of America, Ben Franklin Hall, New York, N. Y.

May 23-26: Design Engineering Conf. & Show. ASME, Coliseum & Statler-Hilton Hotel, New York, N. Y. Banner & Greif, 369 Lexington Ave., New York 17, N. Y.

May 24-26: Convention. Armed Forces Communications & Electronics Assoc., Sheraton Park Hotel, Washington, D. C.

May 25-27: National Specialists Meeting, Guidance of Aerospace Vehicles. IAS, Boston, Mass.

May 31-June 2: Frequency Control Symp. U. S. Army R&D Labs (Sig Corps, Monmouth N. J.), Shelburne Hotel, Atlantic City, N. J.

MIDWEST

May 1-4: 52nd Annual Convention. Nat'l Assoc. of Electrical Distributors, Dallas Memorial Auditorium, Dallas, Tex.

May 1-5: Conf. on Electric Insulation, Electronics, Electrothermics & Metallurgy. The Electrochemical Soc., LaSalle Hotel, Chicago, Ill.

May 2-4: Nat'l Aeronautical Electronics Conf. (Exhibits). IRE (Dayton Section), Dayton, Ohio.

May 3-5: 8th Nat'l Conf. on Electromagnetic Relays. Nat'l Assoc. of Relay Manufacturers, Oklahoma State Univ. Prof. C. F. Cameron, School of Electrical Engineering, Oklahoma State Univ., Stillwater, Okla. (Paper Deadline—3-21-60).

May 5-8: National Convention. (Exhibits). American Women in Radio and TV, Pick-Carter Hotel, Cleveland, Ohio.

May 8-13: Annual Meeting of All Sections. Scientific Apparatus Makers Assoc., Broadmoor Hotel, Colorado Springs, Colo.

May 16-18: Electronic Parts Distributors Show. EIA, Producers of Assoc. Components for Electronics, Western Electronic Mfgs. Assoc., Assoc. of Electronic Parts & Equipment Mfgs., Inc., Conrad Hilton Hotel, Chicago, Ill. Electronic Industry Show Corp., Suite 1500, 11 So. LaSalle St., Chicago, Ill.

WEST

May 1-7: 87th Semi-Annual Conv. & Equipment Exhibit. Soc. of Motion Picture & TV Engineers, Ambassador Hotel, Los Angeles, Calif.

May 2-5: 6th Nat'l Flight Test Symposium. Instrument Soc. of America, San Diego, Calif. Dir. of Tech. & Educational Services, ISA, 313 Sixth Ave., Pittsburgh, Pa.

May 2-6: Western Joint Computer Conf. (Exhibits). IRE, AIEE, ACM, San Francisco, Calif. H. M. Zeidler, Stanford Res. Inst. Computer Tech. Lab., Eng. Div., Menlo Park, Calif.

May 8-14: Annual Tech. Conf. Soc. of Photographic Scientists & Engineers, Miramar Hotel, Santa Monica, Calif. Charles E. Ives, Research Labs., Eastman Kodak Co., Rochester 4, N. Y.

May 9-11: PGMTT Nat'l Symposium. IRE (PGMTT), Del Coronado Hotel, Coronado (San Diego), Calif. Dr. David B. Medved, Chairman, Tech. Prog. Comm., 3628 Poe St., San Diego, Calif. (Paper Deadline—1/15/60).

May 9-12: Instrument Automation Conf. (Exhibits). Instrument Soc. of America, Brooks Hall, San Francisco, Calif. William H. Kushnick, Exec. Dir., ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

May 23-25: 7th Regional Tech. Conf. & Trade Show. Region 7, IRE, Olympic Hotel, Seattle, Wash. Dr. Frank Holman, Boeing Airplane Co., 10708 39th Ave., S.W. Seattle 66, Wash.

May 23-25: Nat'l Telemetering Conf. Inst. of Aeronautical Sciences, Hotel Miramar, Santa Monica, Calif.

JUNE

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	**8**	9	10	11
12	**13**	14	15	16	17	18
19	20	**21**	22	23	24	25
26	**27**	28	29	30		

June 5-9: Semi-annual Meeting. American Soc. for Mechanical Engineers, Statler-Hilton Hotel, Dallas, Tex.

June 8-11: Annual Meeting. Nat'l Society of Professional Engineers, Statler Hotel, Boston, Mass.

June 13-15: Int'l Powder Metallurgy Conf. Metal Powder Assoc., Biltmore Hotel, New York, N. Y. Metal Powder Assoc., 130 W. 42nd St., New York, N. Y.

June 19-24: Summer General Meeting. American Inst. of Electrical Engineers, Chalfont-Haddon Hall, Atlantic City, N. J.

June 21: Monthly Meeting. Radio Club of America, Ben Franklin Hall, New York, N. Y.

June 26-July 1: Annual Meeting (Exhibits). American Soc. for Testing Materials, Chalfonte-Haddon Hall, Atlantic City, N.J.

June 26-29: New England Distributor Conference, Electronic Representatives Assoc., Griswold Hotel, Groton, Conn.

June 27-29: Nat'l Convention on Military Electronics. IRE (PGMIL), Sheraton Park Hotel, Washington, D. C., Dr. Craig Crenshaw Dept. of Army, Office of the Chief Signal Corps, R&D Div., SIGRD-2, Washington 25, D. C. (Papers Deadline - 2-1-60)

June (no date): 9th Annual Convention. National Community Television Assoc., Inc., Miami Beach, Fla. E. P. Whitney, 1111 E. St. N.W., Washington, D. C.

June 27-30: Nat'l Summer Meeting, Inst. of Aeronautical Sciences, Ambassador Hotel, Los Angeles, Calif.

June (No date) 6th National Communications Symposium (Exhibits). IRE, San Francisco, Calif.

SERVO TIME-COMPRESSORS

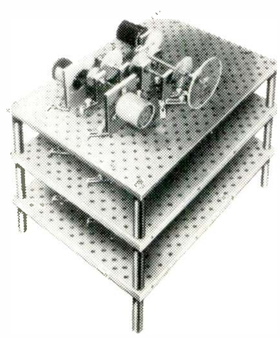
However long it takes you to design, debug, analyze, breadboard, or just feel your way along with your new servo system design, this time can be compressed with any of the expanded line of specialized servo engineering tools listed below. Literally thousands of SERVOSCOPES®, SERVOBOARDS®, and SERVOLABS™ are constantly giving more engineers more time to think.

SERVOSCOPE
Servo System Analyzers measure phase, gain, transient response

The ideal solution for servo system designing, producing, debugging, testing, teaching. Precision SERVOSCOPE instruments are used for analyzing the simplest to the most complex electronic, electrohydraulic, electromechanical, and electropneumatic servo systems. So easy to use, a technician can plot a Nyquist, Nichols, or Bode diagram after only a few minutes' demonstration. SERVOSCOPE provides high-accuracy measurement . . . fast direct setting and readout . . . precise and rapid results . . . with AC carrier and DC systems. Models covering all ranges from .001 to 100 cps. Ask for a demonstration.

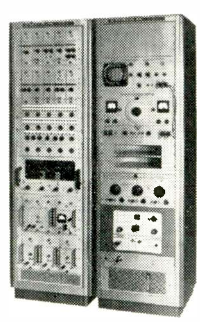
SERVOBOARD
Electromechanical Assembly Kits simplify precision breadboarding

Kits are scientifically designed and packaged by Servo Corp. Selection of components made by experts with years of servo system design and production experience. Rigid mounting board with tapped holes permits easy assembly. Components may be assembled at any angle. Mounting boards stack one on top of the other to save space. Enough components included to meet practically every model-making need. Extra components quickly available out of open stock.



SERVOLAB
Servo System Simulators take idea to prototype stage in one step

SERVOLAB is a packaged assembly of electronic and electromechanical components constituting a versatile synthesis and analysis system. A flexible servo system design, testing, and training tool. Systems simulated with production quality components and subsystems . . . even down to mechanical portions. Non-linearities are simply handled; time-consuming calculations are eliminated. Equipped with idea, screwdriver, and SERVOLAB, engineer can design, breadboard, and analyze in record-breaking time. Time-consuming mechanics are absorbed, giving more time for creative thinking.



SERVO CORPORATION OF AMERICA

111 New South Road • Hicksville, Long Island, New York

JULY

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

MIDWEST

July 11-12: Conf. on Response of Materials to High Velocity Deformation. American Inst. of Mining, Metallurgical & Petroleum Engineers, Estes Park, Colo.

July 11-14: Annual Music Industry Conv. & Trade Show. Nat'l Assoc. of Music Merchants, Palmer House, Chicago, Ill.

July 11-15: 3rd Annual Inst. in Technical & Industrial Communications. Colorado State Univ., Ft. Collins, Colo.

WEST

July 19-21 Western Packaging & Materials Handling Exposition; Pan Pacific Auditorium, Los Angeles, Calif.

July 24-28: 47th Annual Convention. American Electroplaters' Soc., Inc., Statler Hotel, Los Angeles, Calif. Mr. Tony Stabile, 417 E. 16th St., Los Angeles 15, Calif.

IRE PROFESSIONAL GROUPS

PGA—Audio
PGBTS—Broadcast Transmission Systems
PGAP—Antennas & Propagation
PGCT—Circuit Theory
PGNS—Nuclear Science
PGVC—Vehicular Communications
PGRQC—Reliability & Quality Control
PGBTR—Broadcast & TV Receivers
PGI—Instrumentation
PGTRC—Space Electronics & Telemetry (Formerly Telemetry & Remote Control)
PGANE—Aeronautical & Navigational Electronics
PGIT—Information Theory
PGEM—Engineering Management
PGIE—Industrial Electronics
PGED—Electronic Devices
PGEC—Electronic Computers
PGMTT—Microwave Theory & Techniques
PGME—Medical Electronics
PGCS—Communications Systems
PGUE—Ultrasonics Engineering
PGCP—Component Parts
PGPT—Production Techniques
PGAC—Automatic Control
PGME—Military Electronics
PGE—Education
PGEWS—Engineering Writing & Speech

AUGUST

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

EAST

Aug. 6-9: 20th Annual Nat'l Convention (Exhibits). Nat'l Audio-Visual Assoc., Morrison Hotel, Chicago, Ill. James Hulfish, Director of Information, Nat'l Audio-Visual Assoc., Fairfax, Va.

Aug. 8-10: Annual Meeting. (Exhibits) Assoc. of the United States Army, Sheraton-Park Hotel, Washington, D. C.

Aug. 15-17: Heat Tranfser Conf. (Exhibits). ASME, AICE, Statler-Hilton Hotel, Buffalo, N. Y.

Aug. 23-25: Nat'l Meeting, Assoc. for Computing Machinery, Marquette Univ., Milwaukee, Wisc. Dr. J. H. Wegstein, Computation Lab., Nat'l Bureau of Standards, Washington 25, D. C.

Aug. 29-31: Semiconductors Conf., AIME, Statler-Hilton Hotel, Boston, Mass. AIME 29 West 39th St., N. Y. 18, N. Y.

MIDWEST

Aug. 18-19: Electronic Packaging Symposium, Univ. of Colorado, Boulder, Colo.

WEST

Aug. 8-12: Pacific General Meeting: American Inst. of Electrical Engineers, San Diego, Calif.

Aug. 23-26: WESCON. IRE, WCEMA, Ambassador Hotel & Pan Pacific Auditorium, Los Angeles, Calif. Business Mgr., WESCON, 1435 La Cienege Blvd., Los Angeles, Calif.

SEPTEMBER

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

EAST

Sept. 7-9: Joint Automatic Control Conf. IRE (PGAC), ASME, ISA, AIEE, AIChE, Mass. Inst. of Tech., Cambridge, Mass. J. M. Mozley, Johns Hopkins Hospital, Baltimore 5, Md. (Papers Deadline - 3/5/60)

Sept. 11: Fall Meeting. The Material Handling Institute, Inc., The Cavalier Club, Virginia Beach, Va.

Sept. 18-22: 65th Annual Conf. Int'l Municipal Signal Assoc., Astor-Manhattan Hotels, New York, N. Y. Irvin Shulsinger, Conf. Mgr., I.M.S.A., 130 W. 42nd St.

Sept. 19-22: Nat'l Symposium on Space Electronics & Telemetry (Exhibits). IRE (PGSET), Shoreham Hotel, Washington, D. C. H. W. Royce, Glen L. Martin Co., Baltimore 3, Md.

Sept. 21-22: Industrial Electronics Symp. IRE (PGIE), AIEE. J. E. Eiselein, RCA Victor Div., Camden 2, N. J.

Sept. 21-23: Power Conf. ASME, AIEE, Philadelphia, Pa.

Sept. 26-28: 9th Annual Meeting. Standards Engineers Soc., Pittsburgh-Hilton Hotel, Pittsburgh, Pa. J. A. Caffiaux, 11 W. 42nd St., New York 36, N. Y.

Sept. 26-30: Instrument Automation Conf. (Exhibits). ISA, New York Coliseum, N. Y. William H. Kushnick, Exec. Dir., ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

Sept. 26-30: National Fall Meeting. American Welding Soc., Hotel Penn-Sheraton, Pittsburgh, Pa. B. E. Rossi, 33 W. 39th St., New York 18, N. Y.

MIDWEST

Sept. 6-16: Production Engineering Show, Navy Pier, Chicago, Ill. Banner & Freif, 369 Lexington Ave., New York, N. Y.

Sept. 15-16: Engineering Management Conf. American Soc. for Mechanical Engineers, Chicago, Ill.

Sept. 15-17: Electronic Conf. & Exposition. Twin City Electronic Wholesalers Assoc., Electronic Representatives Assoc., Minneapolis Auditorium, Minneapo.is, Minn.

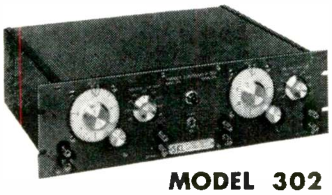
Sept. 18-23: Business Management Institute. Electronic Representatives Assoc., Univ. of Illinois, Monticello, Ill.

Sept. 26-28: Petroleum Mechanical Engineering Conf. American Soc. for Mechanical Engineers, Jung Hotel, New Orleans, La.

SKL PRECISION INSTRUMENTS
FOR YOUR MEASUREMENT PROBLEMS

• QUALITY • ACCURACY • RELIABILITY

VARIABLE ELECTRONIC FILTERS: SERIES 300



MODEL 302

MODEL 300

MODEL 308

. . . For elimination of unwanted signals in your data

. . . For studies in vibration, dynamics, telemetering, acoustics and speech

FUNCTION		High or Low Pass Band Pass or Reject	High or Low Pass	High or Low Pass Band Pass or Reject
Cut-off Freq. Range		20 cps to 200 kc	20 cps to 200 kc	0.2 cps to 20 kc
Atten-uation Rate	Per Section	18 db/octave	18 db/octave	24 db/octave
	Max.	36 db/octave	18 db/octave	48 db/octave
PASS BAND		2 cps to 4 mc	2 cps to 4 mc	2 cps to 1 mc
DIAL ACCURACY		± 3% to 20 kc ± 5% above 20 kc	± 3% to 20 kc ± 5% above 20 kc	± 5%
INSERTION LOSS		0 ± 1 db	0 ± 1 db	4.5 db ± 1 db
NOISE LEVEL		60 microvolts	60 microvolts	60 microvolts

The Series 300 Variable Electronic Filters were developed to meet the problems of inflexibility and expense inherent in conventional multi-frequency filters. Where the fixed filter made for a specific application becomes useless for any other need, the SKL Variable Electronic Filter serves to fulfill broad and diversified laboratory requirements.

Continuous range of cut-off frequency and ability to produce band-pass and band-rejection characteristics with *independent* control of the upper and lower cut-off frequencies are invaluable.

WIDE-BAND CHAIN AMPLIFIERS: SERIES 200

for every application

MODEL 206

The 9 in 1 amplifier providing any combination of:

Gaussian, flat or sloping response curve

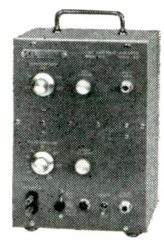
Linear, pulse or high level pulse output mode

MODEL	BANDWIDTH	GAIN	OUTPUT	IMPEDANCE	
				INPUT	OUTPUT
214B	200 cps—90 mc	30 db	125 v, pulse	180	5000
211	15 mc—110 mc	33 db	4 v, rms	50	50
202D	1 kc—210 mc	20 db	4 v, rms	200	200
212C-TV	54 mc—216 mc	20 db	3 v, peak	50 or 75	50 or 75
206	600 cps to 320 mc	18 db to 24 db	(1) 6 v, rms (2) 60 v, pulse (3) 125 v, pulse	180	200

FAST-RISE PULSE GENERATOR

THE Standard for Millimicrosecond Pulses

Model 503 is ideal for testing the transient response of wide band amplifiers and semiconductors. Higher voltage pulses are available through use of an external power supply.



Rise time:	Less than 1 millimicrosecond
Amplitude:	0 to 150 volts
Repetition Rate:	50 to 120 cps
Pulse Width:	.06 x 10^{-10} Sec., Minimum Determined by Length of Width Cable. Max. Width not Restricted. .05 x 10^{-9} Sec., Factory Supplied
Polarity:	Either Positive or Negative
Load Impedance:	50 ohms

For further information write

SKL SPENCER-KENNEDY LABORATORIES, INC.
1320 SOLDIERS FIELD ROAD
BOSTON 35, MASS.

WIDE-BAND TELEVISION DISTRIBUTION SYSTEM: SKL manufactures complete TV distribution systems for community, apartment house and industrial use. Details upon request.

OCTOBER

East

S	M	T	W	T	F	S
						1
2	**3**	4	5	6	7	8
9	10	11	12	**13**	**14**	15
16	**17**	18	19	**20**	21	22
23	**24**	**25**	26	**27**	28	29
30	**31**					

Midwest

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	**10**	11	12	13	14	15
16	**17**	18	19	**20**	21	22
23	**24**	25	26	**27**	28	29
30	31					

West

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	**20**	21	22
23	24	25	26	**27**	28	29
30	31					

EAST

Oct. 3-5: 6th Nat'l Communications Symp. (Exhibits). IRE (PGCS) Rome-Utica Section, Hotel Utica & Urica Memorial Auditorium, Utica, N. Y. W. R. Roberts, 102 Ft. Stanwix Park, Rome, N. Y.

Oct. 13-14: Fall Conf. Nat'l Assoc. of Broadcasters, Biltmore Hotel, Atlanta, Ga.

Oct. 14-15: Rapid Processing Symp. Soc. of Photographic Scientist & Engineers, Shoreham Hotel, Washington, D. C. Charles E. Ives, Chrmn., Research Labs., Eastman Kodak Co., Rochester 4, N. Y.

Oct. 16-22: 5th Int'l Congress on High-Speed Photography & Int'l Equipment Exhibit. (Includes: 88th Technical Conf. of the SMPTE), Sheraton Park Hotel, Washington, D. C.

Oct. 17-19: Lubrication Conf. ASME, ASLE, Statler-Hilton Hotel, Boston, Mass.

Oct. 17-21: Fall Meeting, Metallurgical Soc. of AIME. Institute of Metals Div., Hotel Sheraton, Phila., Pa.

Oct. 20: Monthly Meeting. Radio Club of America Ben Franklin Hall, New York, N. Y.

Oct. 24-26: East Coast Aero. & Nav. Elec. Conf. (Exhibits). IRE, Baltimore, Md.

Oct. 25-27: 11th Nat'l Conf. on Standards. American Standards Assoc., Sheraton-McAlpin Hotel, New York, N. Y.

Oct. 27-29: Electron Devices Meeting. IRE (PGED), Shoreham Hotel, Washington, D. C. T. Liimatainen, 5415 Conn. Ave., N.W., Washington 15, D. C.

Oct. 31-Nov. 2: Radio Fall Meeting. IRE, EIA, Hotel Syracuse, N. Y. Virgil M. Graham, EIA—Eng. Dept., 11 W. 42nd St., New York 36, N. Y.

MIDWEST

Oct. 9-13: Meeting. The Electrochemical Soc., Inc., Shamrock Hotel, Houston, Tex.

Oct. 9-14: Fall General Meeting. American Inst. of Electrical Engineers, Chicago, Ill.

Oct. 10-12: Nat'l Electronics Conf. (Exhibits). AIEE, IRE, Illinois Inst. of Technology, Northwestern Univ., Univ. of Illinois, Hotel Sherman, Chicago, Ill. Arthur H. Streich, Nat'l Electronics Conf., 184 E. Randolf St., Chicago, Ill. (Paper Deadline—5-1-60).

Oct. 17-18: Fall Conference. Nat'l Assoc. of Broadcasters, Sheraton-Dallas Hotel, Dallas, Tex.

Oct. 20-22: Fall Meeting. Nat'l Soc. of Professional Engineers, Hilton Hotel, Denver, Colo.

Oct. 20-22: 7th Annual Int'l Meeting. Inst. of Management Sciences, New York, N. Y. Prof. Robert M. Thrall, Willow Run Labs., P. O. Box 2008, Ann Arbor, Mich.

Oct. 24-25: Fall Conf. Nat'l Assoc. of Broadcasters, Denver-Hilton Hotel, Denver, Colo.

Oct. 27-28: Fall Con. Nat'l Assoc. of Broadcasters, Fontenelle Hotel, Omaha, Nebr.

Oct. (No Date) 7th Western Regional Conf. National Community TV Assoc., Inc., Denver, Colo. NCTA, Inc., E. P. Whitney, 1111 East St., N.W., Washington, D. C.

WEST

Oct. 20-21: Fall Conf. Nat'l Assoc. of Broadcasters, Mark Hopkins Hotel, San Francisco, Calif.

Oct. 27-29: 18th Annual Display of Electrical and Electronic Equipment for Aircraft & Missiles. Aircraft Electrical Soc., Pan Pacific Auditorium, Los Angeles, Calif.

NOVEMBER

East

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	**8**	9	10	11
12	13	**14**	**15**	16	**17**	18
19	20	21	22	23	24	25
26	**27**	**28**	29	30		

EAST

Nov. 8-10: Central States Show. The Material Handling Institute, Inc., Kentucky Fair & Exposition Center, Louisville, Ky.

Nov. 14-15: Fall Conf. Nat'l Assoc. of Broadcasters, Statler Hotel, Washington, D. C.

Nov. 14-16: Meeting. Nat'l Paperboard Assoc., Waldorf-Astoria Hotel, New York, N. Y.

November 14-18: Annual Meeting. Nat'l Electrical Mfrs. Assoc., Traymore Hotel, Atlantic City, N. J.

Nov. 15-16: Northeast Research & Eng. Meeting (NEREM) (Exhibits). IRE (Region 1), Boston, Mass.

Nov. 17: Monthly Meeting. Radio Club of America, Ben Franklin Hall, New York, N. Y.

Nov. 17-18: Fall Conf. Nat'l Assoc. of Broadcasters, Biltmore Hotel, New York, N. Y.

Nov. 27-Dec. 2: Annual Meeting, American Society for Mechanical Engineers, Statler-Hilton Hotel, New York, N. Y.

Nov. 28-Dec. 2: Nat'l Exposition of Power & Mechanical Engineering. American Soc. of Mechanical Engineers, New York Coliseum, New York. O. B. Schier, 29 W. 39th St., New York 18, N. Y.

Nov. (No date) 13th Annual Conf. on Electronic Techniques in Medicine & Biology (Exhibits). IRE (PGME), AIEE, ISA, Washington, D. C.

Nov. (No date) Midyear Meeting of Laboratory Apparatus and Optical Sections. Scientific Apparatus Makers Assoc., Boca Raton, Fla.

Prototype Engineers . . . Specify

ACCURATE PERFORMANCE and DELIVERY

be confident of production reproducibility

DESIGN-IN

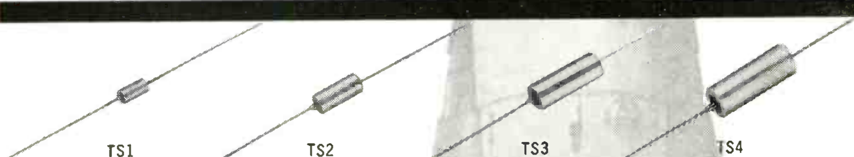
US SEMCOR

ZENER DIODES

VOLTAGE REGULATORS, T$_c$ ≤ .0005%per°C, 1N2163-1N2171A . . . **Z-SZ SERIES,** low power, 1N1927-1N1944, 1N1981-1N1998 . . . **PZ-LPZ SERIES,** medium power, 1N1875-1N1904 . . . **PZT-LPZT SERIES,** double anode medium power . . . **HPZ SERIES,** high power—to 35 watts . . . **GENERAL PURPOSE,** 1N465-1N470, 1N471-1N475, 1N225-1N233, 1N1313-1N1327.

RECTIFIER DIODES

R-SR SERIES, low power, 1N1839-1N1874 . . . **PR-LPR SERIES,** medium power, 1N1907-1N1924 . . . **RR-LRR SERIES,** commercial medium power, 1N2103-1N2114 . . . **HEX MOUNT,** medium power 7/16" 10-32 stud. . . **HPR SERIES,** high power—to 40 amps . . . **GENERAL PURPOSE,** 1N200-1N222, 1N137A, 1N138A.



SOLID TANTALUM CAPACITORS

TS1, size: .125" x .250", .33mfd/35v to 6.8 mfd/6v . . . **TS2,** size: .172" x .438", 4.7 mfd/35v to 56 mfd/6v . . . **TS3,** size: .279" x .650", 15 mfd/35v to 180 mfd/6v . . . **TS4,** size: .341" x .750", 27 mfd/35v to 330 mfd/6v.

Accurate Delivery and Production Reproducibility assured . . .

Another *first!* U. S. SEMCOR now meets your schedules with *accurate delivery* added to exacting Quality Control. The rugged reliability inherent in every U. S. SEMCOR solid state device has been proved many times over in on-the-job tests. To plan ahead with assurance of consistently "over-spec" performance, *specify U. S. SEMCOR products!*

SEND FOR NEW CATALOG . . . or—for a call from our nearest Field Engineering Representative — phone, write or wire collect to Sales Engineering Department.

US SEMCOR

U. S. SEMICONDUCTOR PRODUCTS
3540 West Osborn Road • Phoenix, Arizona • BRowning 2-1341

A Division of TOPP Industries, Inc.

NOVEMBER—*continued*

Midwest

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	**14**	15	16	17	18
19	**20**	**21**	22	23	24	25
26	27	28	29	**30**		

MIDWEST

Nov. 14-16: Mid-America Electronic Convention (NAECON) (Exhibits). IRE, (Kansas City Section), Kansas City, Mo.

Nov. 14-18: Western Tool Show & Semi-Annual Convention. American Soc. of Tool Engineers, Memorial Sports Arena, Los Angeles, Calif. Leonard Abrams, American Soc. of Tool Engineers, 10700 Puritan Ave., Detroit 38, Mich.

Nov. 20-22: Fall Meeting. Fluid Controls Inst., Inc., Drake Hotel, Chicago, Ill.

Nov. 21-22: Fall Convention. Nat'l Assoc. of Broadcasters, Edgewater Beach Hotel, Chicago, Ill.

Nov. 30-Dec. 2: 18th Electric Furnace Conf. American Inst. of Mining, Metallurgical & Petroleum Engineers, Morrison Hotel, Chicago, Ill.

DECEMBER

East

S	M	T	W	T	F	S
				1	2	3
4	5	6	**7**	8	9	10
11	**12**	13	14	15	16	**17**
18	19	20	21	22	23	24
25	26	27	28	29	30	31

EAST

Dec. 1-2: Annual Meeting—Professional Group on Vehicular Communications (IRE) Sheraton Hotel, Phila., Pa. W. G. Chaney, American Tel. & Tel. Co., 195 Broadway, Rm. 1750, New York 7, N. Y.

Dec. 4: 50th Anniversary Banquet. Radio Club of America, Plaza Hotel, New York, N. Y.

Dec. 7-9: 65th Annual Congress of American Industry. Nat'l Assoc. of Manufacturers, Waldorf-Astoria Hotel, New York, N. Y.

Dec. 11-14: Eastern Joint Computer Conf. (Exhibits). IRE (PGEC), AIEE, ACM, Hotel New Yorker, New York, N. Y.

West

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	**12**	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

Dec. 12-15: Industrial Building Exposition & Congress, Coliseum, N. Y. Banner & Greif, 369 Lexington Ave., New York 17, N. Y.

Dec. 17: Wright Bros. Lecture. Inst. of Aeronautical Science, Washington, D. C.

Fall of 1960: 5th Int'l High-Speed Photographic Congress. Soc. of Motion Picture & Television Engineers, Washington, D. C.

WEST

Week of December 12th: Western Atom Show and Atomic Industrial Forum. Atomic Industrial Forum, Fairmont Hotel, San Francisco, Calif.

A REPRINT
of this calendar can be obtained by writing on company letterhead
to The Editor
ELECTRONIC INDUSTRIES, Chestnut & 56th Sts., Phila. 39, Pa.

ABBREVIATIONS USED IN THIS CALENDAR

ACM—Association for Computing Machinery
AEC—Atomic Energy Commission
AEPEM—Association of Electronic Parts & Equipment Manufacturers
AES—Audio Engineering Society
AFOSR—Air Force Office of Scientific Research
AIChE—American Institute of Chemical Engineers
AIEE—American Institute of Electrical Engineers
AIF—Atomic Industrial Forum
AIP—American Institute of Physics
ANS—American Nuclear Society
ARS—American Rocket Society
ASLE—American Society of Lubrication Engineers
ASME—American Society for Mechanical Engineers
ASQC—American Society for Quality Control
ASTE—American Society of Tool Engineers
ASTM—American Society for Testing Materials
AVS—American Vacuum Society
AWS—American Welding Society
EIA—Electronic Industries Association (formerly RETMA)
EJC—Engineers Joint Council
EPMA—Electronic Parts Manufacturers Association
IAS—Institute of Aeronautical Sciences
IEE—Institute of Electrical Engineers (British)
IMSA—International Municipal Signal Association
IRE—Institute of Radio Engineers
ISA—Instrument Society of America
ISU—International Scientific Union
JAN—Joint Army-Navy
MAECON—Mid America Electronics Convention
NAB—National Association of Broadcasters
NAECON—National Aeronautical Electronics Conference
NAED—National Association of Electrical Distributors
NARDA—National Appliance and Radio TV Dealers Association
NARTB—National Association of Radio & TV Broadcasters
NASA—National Aeronautics & Space Administration
NBS—National Bureau of Standards
NCTVA—National Community TV Association
NEDA—National Electronics Distributors Association
NEMA—National Electrical Manufacturers Association
NEREM—Northeast Electronics Research & Engineering Meeting
NRL—Naval Research Laboratory
NSF—National Science Foundations
SMPTE—Society of Motion Picture & TV Engineers
STWE—Society of Technical Writers and Editors
WACM—Western Association of Circuit Manufacturers
WCEMA—West Coast Electronic Manufacturers Association
WESCON—Western Electronic Show & Convention
WJCC—Western Joint Computer Conference

COMING EVENTS CALENDAR

Foreign Events

England

Jan. 18-22: 44th Physical Soc. Exhibition of Scientific Instruments & Apparatus. The Physical soc. (Brit.), London, England.

April 5-9: Electrical Engineers' Exhibition. Electrical Engineers (ASEE) Exhibition Ltd. (Brit.), Museum House, London, England.

May 23-28: Nat'l Instruments, Electronics & Automation Exhibition. Industrial Exhibitions Ltd. (Brit.), Olympia, London, England.

July 21-27: 3rd Int'l Conf. on Medical Electronics. Institution of Electrical Engineers (Brit.), London, England.

Aug. 24-Sept. 3: Radio and TV Exhibition; Earls Court, London, England.

Sept. 5-15: Int'l Scientific Radio Union, 13th General Assembly, University College, London, England.

Canada

June 1-3: 6th Annual Instrumental Methods of Analysis Symposium. Instrument Society of America, Montreal, Canada. Dir. of Tech. and Educational Services, ISA, 313 Sixth Ave., Pittsburgh, Pa.

June 15-17: Meeting. The American Physical Soc., Montreal, Canada.

Russia

June 25-July 9: 1st Congress International Federation of Automatic Control. IRE et al, Moscow, USSR. Eugene Grabbe, P. O. Box 45067, Airport Sta., Los Angeles 45, Calif.

Germany

June 7-11 International Congress on Microwave Tubes; Munich, Germany

France

Feb. 19-23: 3rd Int'l Electric Parts Show. Nat'l Federation of French Electronic Industries, Paris, France.

Feb. 20-29: Component Arts and Electronic Tubes International Exhibition, Porte de Versailles, Place Balard, Paris, France.

Switzerland

Sept. 12-16: 2nd Int'l Congress, Int'l Council of the Aeronautical Sciences. Inst of Aeronautical Sciences, Zurich, Switzerland.

Highlights of 1961

Mar. 20-23: IRE National Convention; Coliseum & Waldorf-Astoria Hotel, New York City. E. K. Gannett, IRE Hdqts., 1 East 79th St., N. Y. 21, N. Y.

Aug. 22-25: WESCON, IRE (All PG's), WCEMA; San Francisco, Calif., Business Mgr., WESCON, 1435 La Cienga Blvd., Los Angeles, Calif.

Sept. 20-21: Industrial Electronics Symposium, IRE (PGIE), AIEE; W. R. Thurston, General Radio Co., Cambridge 39, Mass.

Oct. 9-11: National Electronics Conference, IRE, AIEE, EIA, SMPTE, Chicago, Ill., National Electronics Conference, 184 E. Randolf St., Chicago 1, Ill.

Circle 68 on Inquiry Card

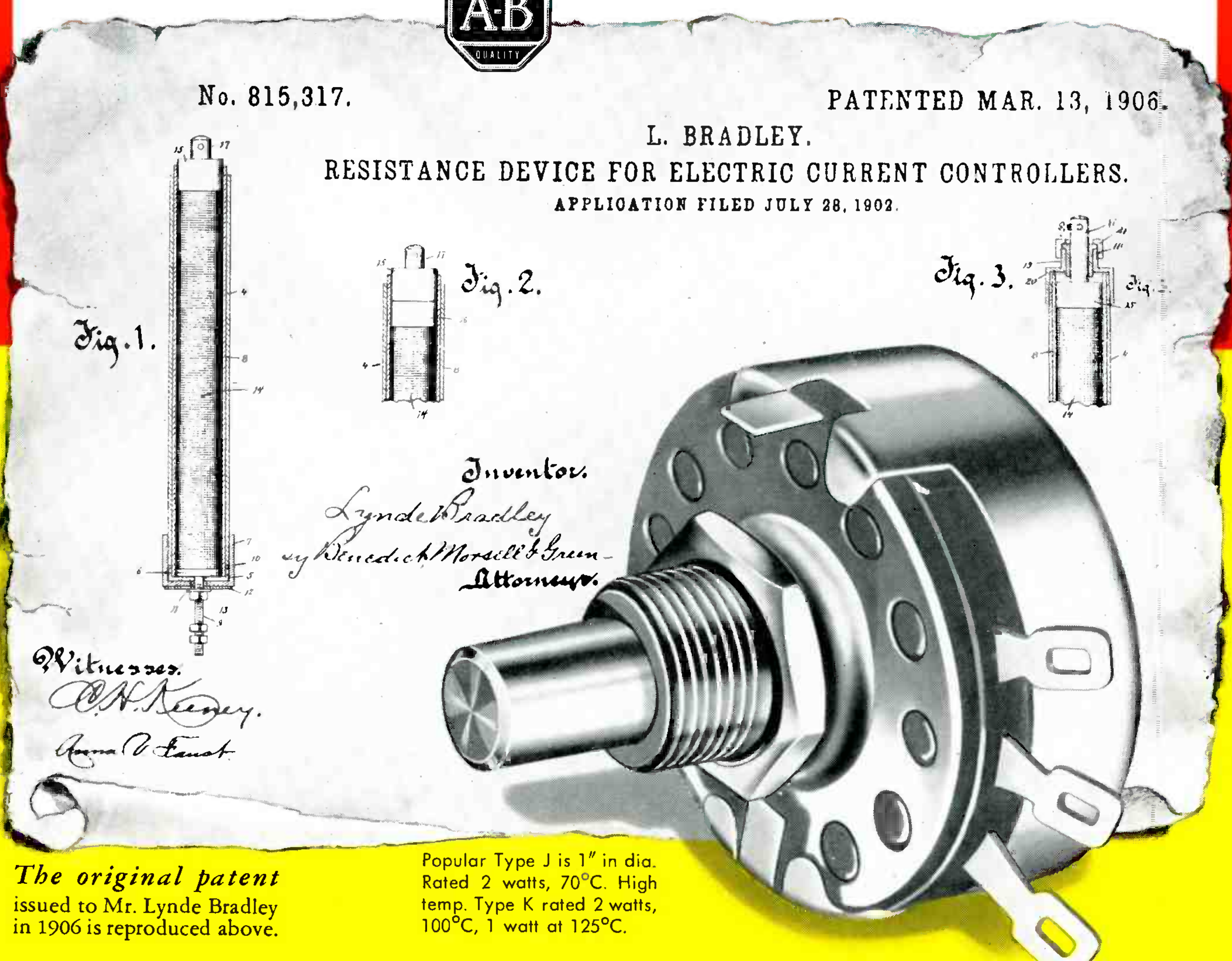
Circle 69 on Inquiry Card →

More than 50 *years*

of Continuous Research

stands behind the Quality "Family" of

Allen-Bradley *Variable Resistors*


No. 815,317. PATENTED MAR. 13, 1906.

L. BRADLEY.

RESISTANCE DEVICE FOR ELECTRIC CURRENT CONTROLLERS.

APPLICATION FILED JULY 28, 1902.

The original patent issued to Mr. Lynde Bradley in 1906 is reproduced above.

Popular Type J is 1" in dia. Rated 2 watts, 70°C. High temp. Type K rated 2 watts, 100°C, 1 watt at 125°C.

Tiny Type G, ½" dia. Rated ½ watt, 70°C. Type L, ½ watt, 100°C.

New Type R adjustable fixed resistor rated ¼ watt at 70°C ambient.

For over half a century, Allen-Bradley has set the pace in the development of quality variable resistors—and continues to do so today! With the original patent, illustrated above, Allen-Bradley introduced a new concept in the field of variable resistors. And in the early days of radio, Allen-Bradley variable resistors were so universally accepted for their smooth control that famous "Bradleystats" were a byword of the wireless era.

From this unique background comes today's famous A-B family of variable resistors, all of which feature the solid, hot molded resistance element—an *exclusive* A-B design that has proven unequaled for reliability and long life. It is because of this superlative performance that Allen-Bradley variable resistors enjoy the enviable reputation of being "required" in so many critical military and industrial applications.

Allen-Bradley Co., 222 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY

Quality Electronic Components

6-59-E

FREE BULLETIN...

TURN TRASH INTO CASH

Just produced by Handy & Harman—this new Refining Bulletin describes the great cash potential in precious metals industrial waste . . . lists many possible sources. Types and forms of refinings are illustrated photographically and described in text. Equally important, the bulletin calls attention to the fact that much of industry's valuable waste is truly wasted.

For your free copy of this new and cash-provoking bulletin, write to Refining Division, Handy & Harman, 82 Fulton Street, New York 38, N.Y. Your biggest dividend will come when you send a refining lot to Handy & Harman and see for yourself the cash benefits you get from the country's leading refiner of precious metals waste.

Your No. 1 Source of Supply, Refiner and Authority on Precious Metals Alloys

Refining Plants & Collecting Stations:

Bridgeport 1, Conn.

Chicago 22, Ill.
1900 W. Kinzie Street

Providence 3, R. I.
425 Richmond Street

El Monte, Calif. (Los Angeles)
330 North Gibson Road

New York 38, N. Y.
82 Fulton Street

Toronto 2B
141 John Street

HH

HANDY & HARMAN

General Offices: 82 Fulton St., New York 38, N.Y.

←——Circle 70 on Inquiry Card

Circle 71 on Inquiry Card

Eyelet

(*Continued from page 89*)

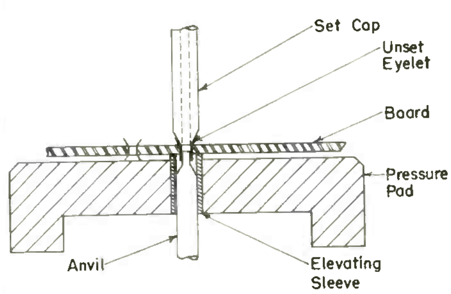
flaring surface of the anvil. In operation the eyelet is completely through the board with head of the eyelet firmly seated against the top side of the board before the eyelet begins to flare.

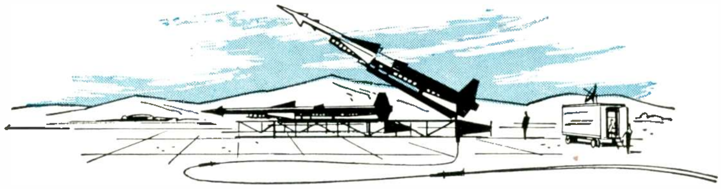
The firm has also developed two machines designed specifically for high production and extreme reliability in printed circuit eyeletting.

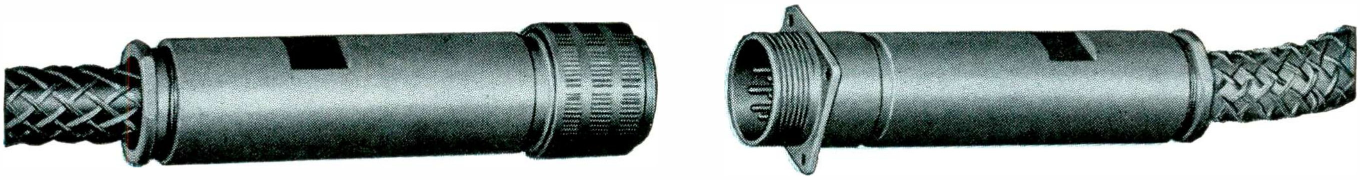
The Model ESSM was developed cooperatively with Bell Laboratories to stake and fuse simultaneously. The eyelets are pure copper, flat flange, tin or lead plated; the boards are solder plated and fluxed. During the eyeletting process a high amperage low voltage charge is sent through the electrode dies. With this machine a mechanical joint as well as a fused joint is obtained. Sectioned views show a solder joint between the flange and the circuitry, between the rollover and circuitry, and a fillet of solder around both the flange and the roll-over. Extreme reliability is thus obtained at a minimum of cost, manual soldering being completely eliminated on through connections.

The NRSW was developed for the General Electric Co. but is now available for industry-wide use. In this machine, a solder washer is manufactured, fluxed, and clamped under a gold-plated funnel flange eyelet at each stroke. A strip of 0.020 in thick solder is fed through the machine to make the washer. The under side of the board is funnel set and later dip soldered. The captive washer can be fused during the dip soldering process or in a separate fusing operation depending on the size of the eyelet and washer.

Funnel flange eyelet prior to staking.







Why it pays you to specify

Bendix QWL Electrical Connectors for use with Multi-conductor Cable

For use with multi-conductor cable on missile launching, ground radar, and other equipment, the Bendix* QWL Electrical Connector meets the highest standards of design and performance.

A heavy-duty waterproof power and control connector, the QWL Series provides outstanding features: • The strength of machined bar stock aluminum with shock resistance and pressurization of resilient inserts. • The fast mating and disconnecting of a modified double stub thread. • The resistance to loosening under vibration provided by special tapered cross-section thread design. (Easily hand cleaned when contaminated with mud or sand.) • The outstanding resistance to corrosion and abrasion of an aluminum surface with the case hardening effect of Alumilite 225 anodic finish. • The firm anchoring of cable and effective waterproofing provided by the cable-compressing gland used within the cable accessory. • The watertight connector assembly assured by neoprene sealing gaskets. • The additional cable locking produced by a cable accessory designed to accommodate a Kellems stainless steel wire strain relief grip. • Prevention of inadvertent loosening insured by a left-hand accessory thread. • The high current capacity and low voltage drop of high-grade copper alloy contacts. Contact sizes 16 and 12 are closed entry design.

These are a few of the reasons it will pay you to specify the Bendix QWL electrical connector for the job that requires exceptional performance over long periods of time. *TRADEMARK

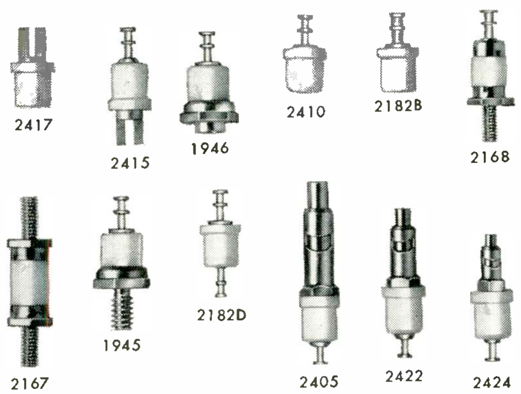
Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y. Canadian Affiliate: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal 9, Quebec. Factory Branch Offices: Burbank, Calif.; Orlando, Florida; Chicago, Ill.; Teaneck, New Jersey; Dallas, Texas; Seattle, Washington; Washington, D. C.

Scintilla Division
Sidney, New York

Bendix
AVIATION CORPORATION

Circle 74 on Inquiry Card

Build STAMINA Into Your Circuits



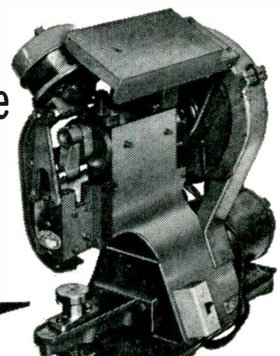
SHOWN ACTUAL SIZE

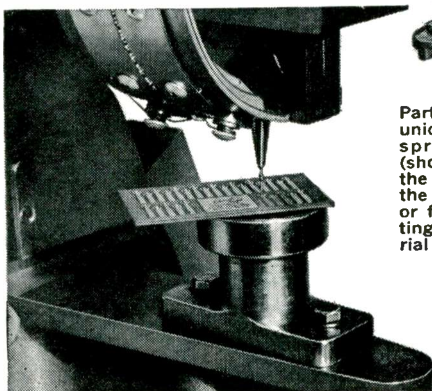
CAMBION® Teflon-insulated terminals and diode clips offer a wide choice of quality-guaranteed components designed to withstand the shock and vibration of today's toughest operating and service requirements. Uniquely fastened Teflon sections provide positive, press-type mountings as well as superior insulation. Spring-loaded diode clips for wire diameters up to .085″ and ferrule contact types for pins up to .085″ diameter assure tight, troublefree connections. Terminals and clips brass per QQ-B-626a ½ hard. Terminals silver plated, clips bright alloy plated unless otherwise specified. Get complete information. Write Cambridge Thermionic Corporation, 504 Concord Avenue, Cambridge 38, Massachusetts.

Circle 75 on Inquiry Card

PLANNING FUNNEL TYPE EYELETS FOR PRINTED CIRCUIT BOARDS?

this Edward Segal automatic machine feeds, inserts and flares with utmost reliability!





Part of the secret's in Segal's unique anvil tool holder and spring loaded work table (shown at left) which allow the eyelet to pass through the assembly before staking or flaring. Avoids loose settings, compensates for material variations, too.

There's a Segal machine for every eyeleting application. Tell us about yours and we'll gladly look into it without obligation. And write today for new bulletin EI-12

Edward Segal
Manufacturers of eyeleting machinery, special hoppers and feeding devices
132 LAFAYETTE STREET, NEW YORK 13, N.Y.

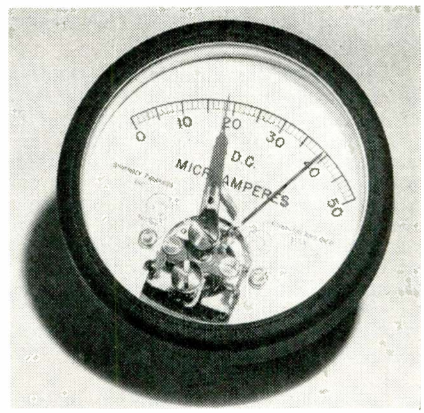
Circle 76 on Inquiry Card

Meter

(Continued from page 102)

the toggle the other way and again pushes past, opening the booster circuit once more.

The design and positioning of the toggle are such that a contact on the indicating pointer always passes by the toggle arm closer to it and strikes the contact on the further arm. The indicating pointer has two isolated contacts, one touching a toggle contact while



Indicating pointer has passed set point but control circuits remain energized. Note position of toggle, on adjustable pointer.

moving upscale, the other being operative when the pointer moves downscale.

Movement of pointer contacts across the toggle contacts exerts a wiping action that keeps contacts clean and makes for more positive action and longer contact life.

Microwave Refractometer

Improved airborne microwave refractometer, model 3, for use in small aircraft, has been developed by the National Bureau of Standards, Lower Atmosphere Physics Section, Radio Propagation Engineering Div., Boulder Colorado.

It is used to make direct airborne measurements of the radio refractive index of the air for use in radio propagation and micrometeorological studies of the lower atmosphere. It has the same electrical performance as the Model 2 but is only 8 x 5 x 13 in. and requires only 3.5 a at 28 vdc. Weight is 17 lb compared with Model 2's 50 lb.

USE LOTS OF TAPE?

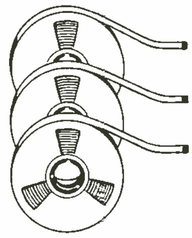
"SCOTCH" BRAND Instrumentation Tapes cut operating costs

Let's develop our own small theory of relativity. For everything's relative, after all—even economy. Clearly, an economy effected now and *corrected* later is no economy at all. In instrumentation tape, there's only one genuine economy—reliable performance. And in performance, the last two words for any acute tape-user are "SCOTCH" BRAND.

First to last, "SCOTCH" BRAND Magnetic Tapes offer uniformity and reliability—born of the experienced 3M technology that created the first practical magnetic tape and continues to advance the art of tape-making day by day.

But let's look at economy from another viewpoint—in terms of some things around the periphery that might not come so readily to mind—storage, use, waste, and time saved.

What other kind of record is so permanent it may last a lifetime, yet requires so little space for storage? Three reels of "SCOTCH" BRAND like those at the right "contain" 30 million characters. What other medium serves input, output and memory functions at such high speeds? Accepts both digital and analogue data?

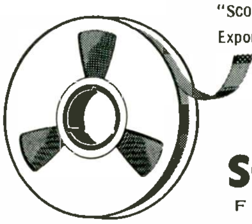


What other kind of record is not *consumed,* even when it is used? "SCOTCH" BRAND Magnetic Tape is run and rerun for analysis, erased and used again, permits retaping with corrections, editing and new data.

Last, but far from least—in these days when time is money, what other medium speeds up data acquisition, reduction and control programming in a way that keeps critical projects rushing forward at full tilt? Or cuts production lead time and human error to a point where a 1000% saving may be realized?

At any cost, "SCOTCH" BRAND Magnetic Tapes would be a good buy. And in every application, "SCOTCH" BRAND Tapes offer that greater economy—reliability. "SCOTCH" BRAND High Resolution Tapes 158 and 159 let you pack more bits per inch, offer extra play reels. "SCOTCH" BRAND Sandwich Tapes 188 and 189 end rub-off, build-up, cut head wear to an absolute minimum, show little wear in 50,000 computer passes. "SCOTCH" BRAND High Output Tape 128 offers top output at low frequencies, even under ambient temperature extremes. "SCOTCH" BRAND Instrumentation Tapes 108 and 109 offer top performance at lowest cost.

Where there's no margin for error, there's no tape like "SCOTCH" BRAND Magnetic Instrumentation Tape. For details, write Magnetic Products Div., 3M Company, Dept. MBR-129, St. Paul 6, Minn., or mail the reader inquiry card.



SCOTCH BRAND MAGNETIC TAPE
FOR INSTRUMENTATION

MINNESOTA MINING AND MANUFACTURING COMPANY
. . . WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

Circle 78 on Inquiry Card

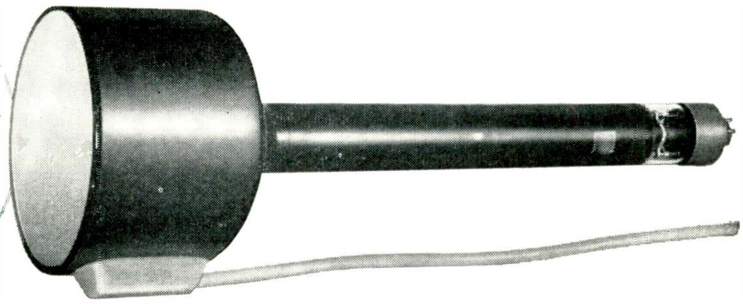
"RADIO STAMPS"

This is a new set of Czechoslovakian postage stamps honoring radio and communication pioneers scheduled for release Dec. 7, 1959, coinciding closely with the 50th Anniversary Banquet of the Radio Club of America, Dec. 4. Noted radio-electronic inventor, E. H. Armstrong is the American in this international group. Illustrations for this series were provided by Herbert Rosen, President, Industrial Exhibitions Inc., 17 E. 45th St., N. Y. C. and of Radio Philatelia, a book tracing the history of communications in stamps issued through the years. Interpex, next international stamp exhibition will be held Feb. 27-Mar. 1, 1960 at Park Sheraton Hotel in N. Y. C.

FEATURES

- Eliminate need for extra gadgetry (no centering-beam magnets)
- Spot sizes are guaranteed to be no longer than advertised
- Spot size at beam currents higher than any comparable tube
- UNPRECEDENTED!—Offered in 3 phosphors: P1, P11, P16

for
Flying Spot Scanners, Precision Radar, Photographic and Intermediate Film Transmission Systems



Our resolution will continue to be the highest and most extensive available –without gimmicks!

Another first—Du Mont's high-resolution line of cathode-ray tubes is now available in *three different phosphors*. Du Mont, the pioneer in high-resolution cathode-ray tubes, is not only the leader in such *developments*—but the leader in *producing* a variety of such tubes to satisfy the many needs of industry. When spot sizes become smaller, and the useful variations in such tube types becomes greater—they will first come from Du Mont!

DU MONT HI-RESOLUTION TUBES FOR IMMEDIATE DELIVERY

Tube Size	Spot Size*	Type	Phosphor Types (fine grained)
3"	0.8 mil	Magnetic deflection and magnetic focus	P1, P11 or P16
5"	1 mil	"	"
7"	1.5 mils	"	"
3"	0.8 mil	Magnetic deflection and electrostatic focus	"
5"	1 mil	"	"
7"	1.5 mils	"	"

DU MONT SUPER HI-RESOLUTION TUBES FOR IMMEDIATE DELIVERY

Tube Size	Spot Size*	Type	Phosphor Types (fine grained)
3"	0.7 mil	Magnetic deflection and focus	P1, P11 or P16
5"	0.7 mil	"	"

* We GUARANTEE that the specifications given are the maximum spot sizes (measured by shrinking raster method).

Write for complete technical details
ELECTRONIC TUBE SALES

DU MONT®

precision electronics is our business

ELECTRONIC TUBES/INDUSTRIAL TV/MILITARY ELECTRONICS/MOBILE COMMUNICATIONS/SCIENTIFIC INSTRUMENTS/AUTOMOTIVE TEST EQUIPMENT

Allen B. Du Mont

ALLEN B. DU MONT LABORATORIES, INC., CLIFTON, N. J., U. S. A.

INTERNATIONAL DIVISION • 515 MADISON AVENUE, NEW YORK 22, N. Y. • CABLES: ALBEEDU, NEW YORK

Firing Ceramics

THE process of firing steatite ceramic parts, used in electron tubes, to high tmperatures, and effecting necessary changes in their composition, entails critical time-temperature relationship and control. In transforming the fragile, unfired powder preform to finished ceramic form, desired electrical characteristics must be precisely developed. The ceramic pieces must be fired to exact dimensions and density.

This operation, which demands the ultimate in proper firing and uniform heat transfer, is one that Western Electric at its Allentown, Pa., Works has perfected with the use of a Gradiation periodic kiln, Fig. 1.

Abstracted from a paper by GORDON D. SMITH, Application Engineer, Furnace & Kiln Div., Selas Corp. of America, Dresher, Pa.

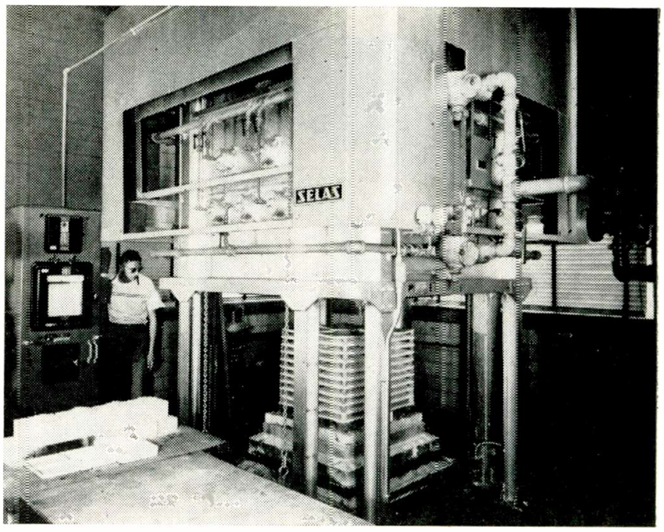


Fig. 1: Elevator car, loaded with 12,000 ceramic pieces, is ready to be raised into position.

The heating unit was specially designed and built by Selas Corporation of America, Dresher, Pa., to fire ceramic piece parts such as cathode support insulators for microwave amplifier tubes and structural members for other electron tubes. As many as 12,000 pieces at a time can be uniformly heat processed in this kiln with a minimum of rejects.

Heating-Operation

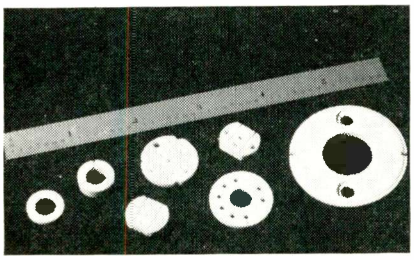
The different ceramic parts fired in the Duradiant-burner-fired kiln, several are shown in Fig. 2, are composed of talc, kaolin, barium and magnesium carbonates. They must be fired at temperatures ranging from 2280°F to 2320°F, the exact temperature depending on the forming technique that precedes the heating process, i.e., whether formed by powder press, extruder, or slug press.

Once formed, the ceramic parts are transported to the Selas kiln and carefully loaded onto 36 or 40 mullite firing plates. The plates are arranged four on a level and stacked nine to ten plates high, as shown in Fig. 3.

Next, the Duradiant burners on each of the four walls are lighted, stabilized, and the elevator car is raised to position in the kiln.

The heating operation proceeds as follows: a scheduled time of approximately 4½ hr. is allowed to bring the kiln heating chamber up to the desired temperature, between 2280°F and 2320°F. A soaking period of 5 hr. at the preset temperature is then maintained with accuracy, not varying more than ±10°F, and radiant heat is distributed uniformly throughout the entire 12,000-ceramic-piece workload.

Fig. 2: Various types of ceramic piece parts fired in the kiln are composed of talc, kaolin, barium and magnesium carbonates. Two pieces at left are the ones loaded on the elevator car in Fig. 1.



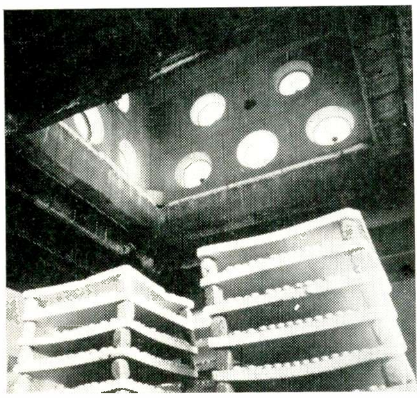


Fig. 3: A look into the heating chamber shows the pattern of the Duradiant burners in one wall. They have been lighted, stabilized, and are ready to fire the workload.

It is during this 5-hr. period of firing at high temperature that the raw materials are transformed into non-porous, low loss, insulating products, which perform exceptionally well at high frequency applications. Holding the temperature at the exact pre-determined level and distributing the radiant heat uniformly to the ceramic piece parts are vital to the establishment of proper crystalline formation, with a resulting loss factor controlled below 0.004 when measured at room temperature and 1 MC. Dimensions within workload are held to ±0.003 in.

After 5 hr. the burners are shut off and the workload is allowed to cool slowly to approximately 1000°F inside the kiln before being lowered and exposed to room temperature. This controlled cooling, which takes about 15 hr. prevents spalling of the workpieces and furnace lining.

Reactance Computer

JFD Electronics Corp., 6101 16th Ave., Brooklyn 4, N. Y., is offering a plastic slide rule ($1.00) which determines resonant frequency of a circuit and inductance and capacitance. It also can be used for computing inductance and capacitive reactance of resonant circuits from 1 to 1,000 MC.

STERLING ...the *complete* component line

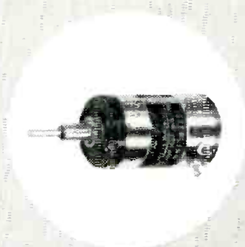
20,000

Quality Components

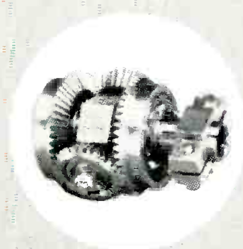
immediately available from stock

Precision made magnetic clutches and brakes, differentials, gear heads, precision gearing and a wide variety of precision electromechanical components, described in this convenient engineering handbook, are included in Sterling's unique "from stock" policy.

Write today for Complete Catalog #61 which includes engineering data, dimensional diagrams, prices and other product information.



68 DIFFERENT CLUTCHES AND BRAKES



48 TYPES DIFFERENTIALS

24 STYLES GEAR-HEADS AND SPEED REDUCERS THOUSANDS OF RATIOS

PRECISION 1, 2, 3 AND ULTRA PRECISION GEARS FROM STOCK

STERLING
PRECISION CORP.
17 MATINECOCK AVENUE
PORT WASHINGTON, L. I., NEW YORK

Tele-Tech's
ELECTRONIC OPERATIONS

The Systems Engineering Section of ELECTRONIC INDUSTRIES • DECEMBER 1959

SYSTEMS—WISE . . .

▸ The FCC took steps to comply with a 1958 amendment (Public Law 85-817) to the Communications Act to enable it, in the interest of air safety, to waive the citizenship requirement and license certain aliens to operate radio on aircraft.

▸ The Merit Award of the American Radio Relay League for 1959 went to James J. Lamb, South Norwalk, Conn., for his significant contributions to the welfare of amateur radio. Lamb was presented the award at the New England Division Convention of the League, at Hartford, Conn.

▸ In its first real step towards automation, the Veterans Administration placed into service an IBM 705, III, Electronic Data Processing System at its Philadelphia District Office. The unit will allow the VA's Dept. of Insurance to give better service to its 6½-million accounts. Phila. handles ⅔ of all the accounts in the country and is the largest of the three VA insurance offices. The others are at Denver and St. Paul.

▸ The radio (AM and FM) and TV broadcasting industry for the calendar year 1958 reported total revenues of $1.6-billion or 6.3% above 1957. The 1958 TV revenues were $1,030-million or 9.2% up, while radio revenues rose 1.0% to $523.1-million.

▸ Two more volumes of the FCC's Rules and Regulations have been placed on sale. Vol. III, containing rules relating to all Broadcast Services (Parts 3 and 4) and Vol. VI, containing the rules relating to Amateur, Citizens and Disaster Services (Parts 12, 19, and 20), are available.

▸ An agreement relating to the manufacture of distribution equipment and installation of distribution systems for closed-circuit pay-as-you-see TV has been signed by International Telemeter Co., a division of Paramount Pictures Corp., and Jerrold Electronics Corp. Arrangements have also been made for continued joint engineering development in the field.

AIRBORNE TELEVISION

Experimental Westinghouse Stratovision station which first demonstrated the feasibility of airborne telecasting. This technique will be used by the Midwest Council on Airborne Television Instruction to make available instructional TV programs over a 6 state area.

▸ A radically new and simple electronic space camera that can take a continuous strip of weather pictures around the world and turn them into TV signals for broadcast to the ground, is under development by the Radio Corp. of America for satellite use.

WEATHER VIA TV

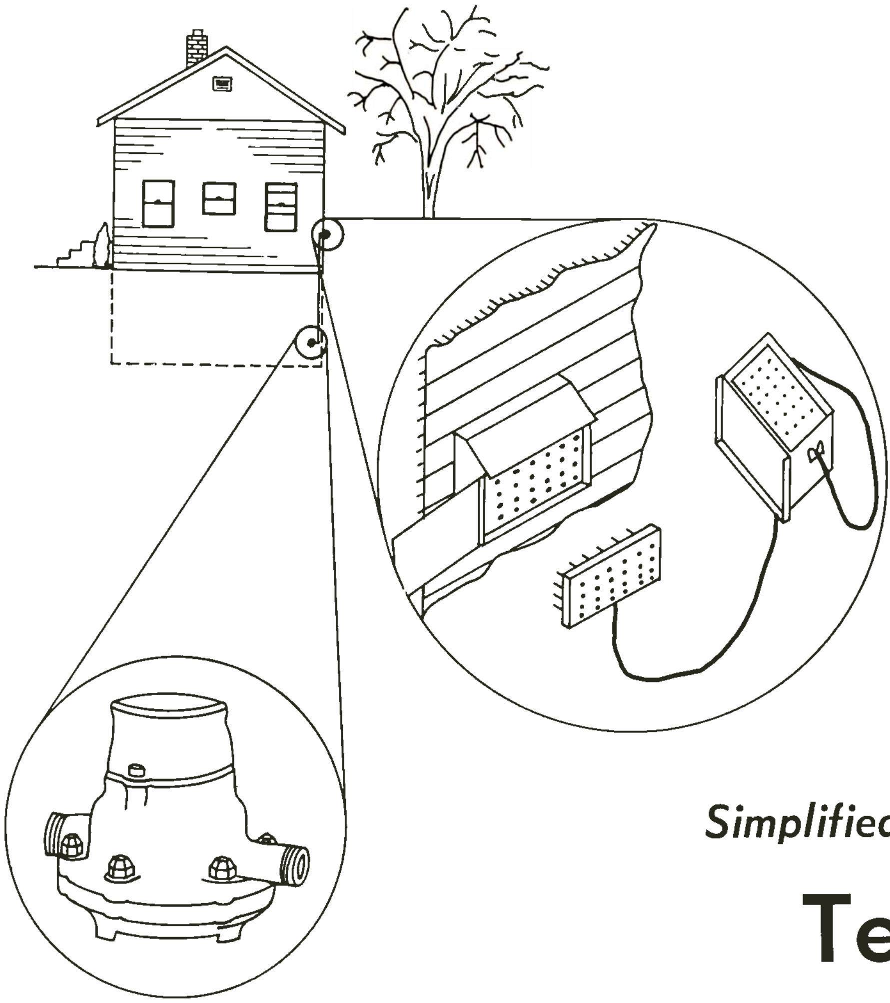
Base weatherman flashes up-to-date weather information via closed circuit TV to a jet pilot about to take off on a training mission. The system, developed by GE, is the first to be used in the New York metropolitan area.

▸ An instrument, no larger than the average workman's toolbox, but with the ability to make highly accurate spot checks of small parts during production runs is the RCA Limit Signaling Comparator. It operates on radio frequency and gives instantaneous response. This precision instrument is ideal for inspecting materials as they are received from a supplier, spot checking during production runs, or post process gaging.

▸ The USAF has placed an order with Western Union for a high-capacity communication system which will make necessary the construction of a microwave beam system from coast-to-coast. The new transcontinental leased wire system could provide, in addition to the Air Force broadband data facilities, 12,000 telegraph circuits simultaneously for Western Union's own expanding requirements.

▸ The FCC denied those portions of the Nov. 3, 1958 petition by the Joint Council on Educational Television requesting (1) a general policy announcement that VHF channels which may in the future become available in metropolitan areas will be reserved for noncommercial educational use if a VHF channel has not previously been reserved; and, (2) rulemaking to reserve VHF channels for noncommercial educational TV use in Waycross, Ga., and Norfolk-Portsmouth-Newport News, Va.

▸ New techniques for the transmission and reception of "narrow-band" TV, developed by CBS Laboratories, Stamford, Conn., can accommodate a picture highly suitable for educational TV and double the number of channels which can be made available for educational TV within a given portion of the UHF spectrum. The new techniques will be incorporated into the full-scale field trial of airborne educational TV being undertaken by the Midwest Council on Airborne Television Instruction. See illustration.



Telemetering system reads meters at remote locations. Readings can be transferred directly to IBM cards, or special sensitive paper.

By **PAUL C. CONSTANT, Jr.**
Midwest Research Institute
Kansas City, Missouri

Simplified System for

Telemetering

Remote reading of home meters would reduce costs and errors. The system could be extended to many shaft driven indicating devices.

IT is often difficult to obtain periodic readings of home water meters. This telemetering system alleviates many of the difficulties. The system is quite simple, requiring only four basic items of equipment; a transmitter, a multi-conductor transmission line, an external plug receptacle, and a portable recorder or receiver (a read-out device). The purpose of the system is to facilitate reading meters at remote locations.

Present systems

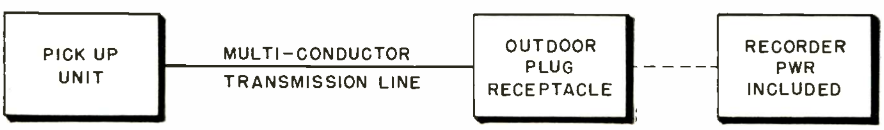
Most water meters indicate consumption with a mechanical gear linkage system having seven outputs in the form of calibrated dial plates driven directly off gear shafts. The calibrated dials are based on the decimal system of counting. The seven dial indicators are coupled so that a maximum consumption of 10,000,000 cu. ft. may be indicated before recycling occurs.

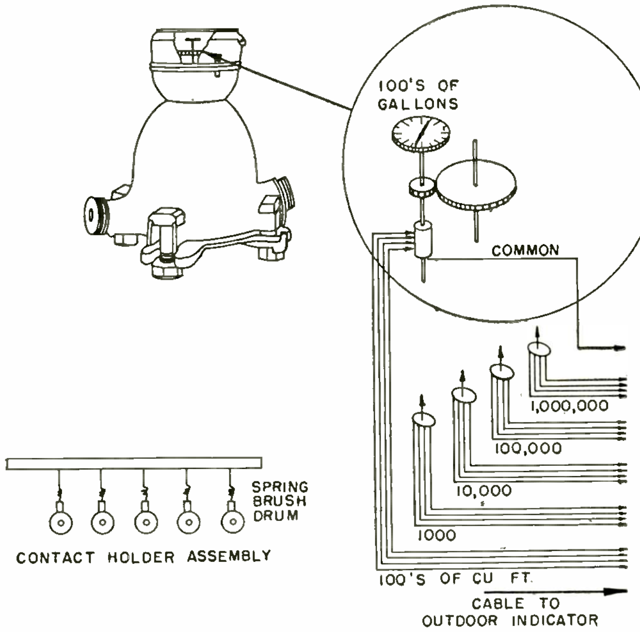
A new system

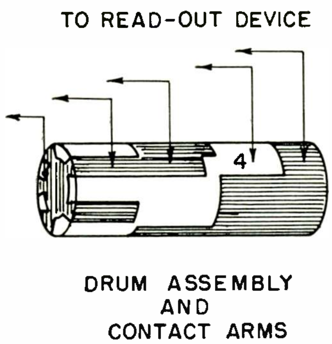
Fig. 2 show a system based on the binary-coded decimal system of counting. This system uses a minimum number of electrical connections to convey the information appearing on the dial face indicators. The information on one dial can be conveyed with four wires plus a common ground through contact points on a commutator drum (Fig. 3). The information on more than one dial can be telemetered with a transmission cable of (4n+1) conductors, where n is the number of dials. The lesser number of conductors for n>1 is because the return path is common to each drum assembly (Fig. 5). For a seven dial meter, 29 conductors are required.

Fig. 3 shows one drum unit. There are four brushes resting on the drum assembly. Depending upon the dial reading, each brush will or will not be in contact with the commutator. As shown, only only one brush rests on the commutator, giving the binary equivalent 0100. This is the digit 4 in

Fig. 2: System needs no permanent power supply. Power is obtained from the portable recording instrument.







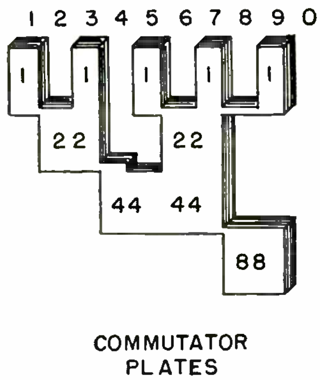


Fig. 3 (Left): Brushes read consumption in a 4-digit, binary code, from position on commutator.

Fig. 4 (Right): Commutator plate is embedded in the drum which is an electrical insulator.

Home Water Meters

decimal form. Hence, if this drum represents the "units" digit, the dial reading is 4 cu. ft.

A pick-up device (a drum assembly) is attached to each gear shaft of each dial unit. Each pick-up unit is in essence a generator capable of delivering a signal containing the information of one dial setting at any time via a transmission line to a distant receiver. There are seven identical drum units, one for each dial station. One brush assembly having 5 individual brushes (Fig. 3) is used with each drum unit.

The telemetered information at the receiving end is recorded on a punched-card, graphically, on a chart, or by a system of neon bulbs. The recording device can be simple or complex. depending upon whatever form is necessary for the display of the required information. The overall telemetering system is shown in Fig. 1.

Transmitting devices

The form of the transmitting device (generator or pick-up unit) is shown in Figs. 2 and 3. In this arrangement a drum which is an electrical insulator is secured to the shaft of an existing meter gear. Embedded in the drum are electrical commutator plates, commonly connected.

A spring loaded, five-brush assembly (one brush for the common ground connection) is positioned so that the brushes will be in contact with the drum unit, and the commutator plate. As the drum rotates with water consumption, the brushes contact the proper portions of the commutator and pick up the consumption information.

By extending the gear shafts through the dial faces; the drum assembly units, and pick-up unit assembly, can be located outside the meter housing. Advantages of such a system include: simplicity of meter modification, and elimination of the need for a waterproof hous-

(*Continued on page* 188)

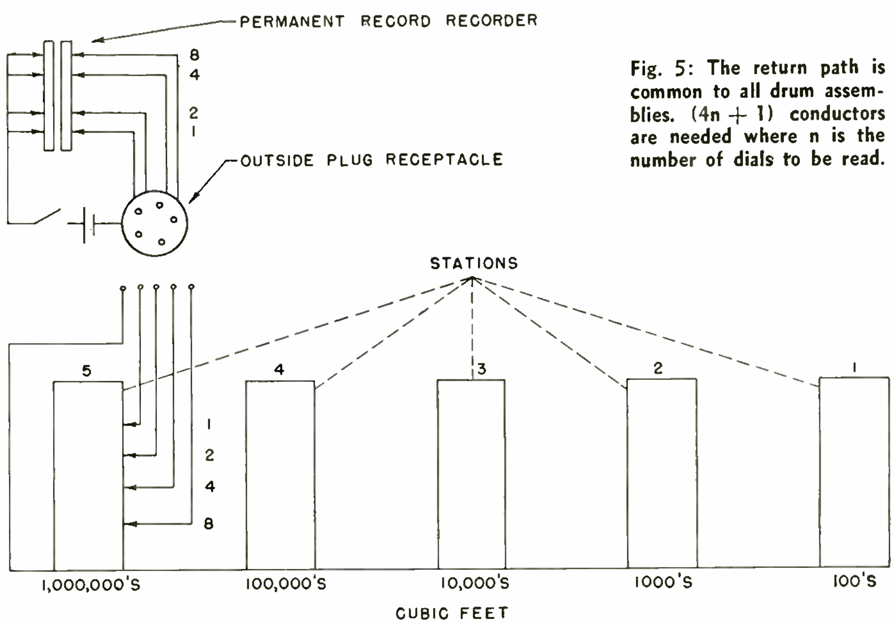


Fig. 5: The return path is common to all drum assemblies. (4n + 1) conductors are needed where n is the number of dials to be read.

CUES for Broadcasters

Rejuvenating RPX Cartridges

NORMAN F. ROUND, Ch. Engr. WCCM, Lawrence, Mass.

After having a few GE RPX cartridges gradually lose their output voltage I decided to find out why. Testing them revealed good continuity and ohm readings. When placing the tip of a screwdriver on the cartridge magnet, I found that some magnets had more attraction than others and therefore concluded that these were the culprits. With less magnetic force, less induced voltage would result. Just take the cartridge apart, remove the magnet, and order some more from GE at $1.00 apiece. In the meantime, buy a TV positioning magnet, hacksaw it into pieces of approximately the right size and install them in the cartridges. They do not have to be round in shape but make certain that they are in far enough to be as close to the stylus as possible without touching it. It's a good idea to glue them in. Always choose the pieces that have the most magnetic attraction.

These have operated so well that I have not bothered to change them. All of our original RPX cartridges are still in use along with some new ones and the difference in quality is undiscernible. It's always a good practice to use a test record on cartridges occasionally to make certain that their quality is still good. It may be possible to remagnetize the old magnets by wrapping a coil around them and putting a strong dc current in the coil. Other makes of magnetic cartridges may also be benefited by magnet renewal.

While your working on these cartridges, it's also a good idea to drill a small hole in the pickup arm head, whether it's a plug-in type or part of the arm itself, for easy removal of the stylus. On old type single stylus RPX cartridges, it can be quite a chore to remove the stylus. "With a hole in the head," stylus removal is easy. Just use a paper clip to push it out.

Foolproof AC—DC Switching

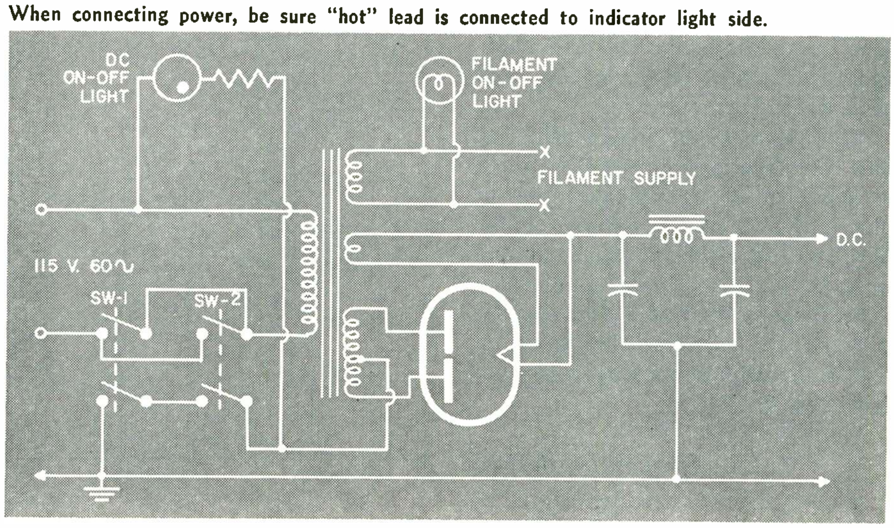
It is well known that in order not to damage tubes in a circuit the ac voltages to a system should be applied before the dc. Normally, two switches are supplied for this purpose. However, errors have arisen whereby the dc switch has been turned on before the ac. In order to circumvent this condition, the circuit shown can be applied.

With both switches off, no filament voltage or plate voltage is applied. Toggling any one switch causes the filaments to be fired. Toggling the second switch applies the plate voltage to the rectifier circuit. As will be seen, it is immaterial which switch is applied first.

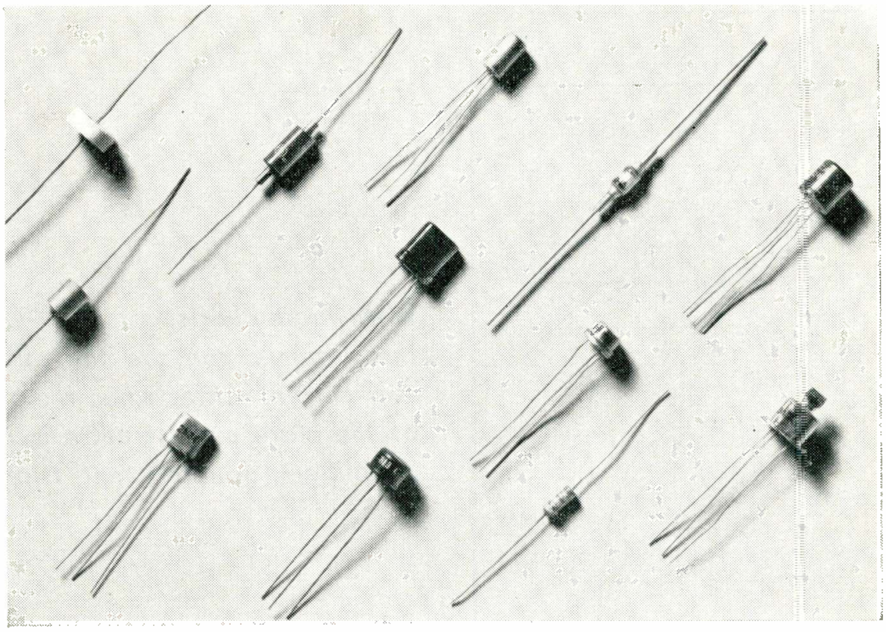
In the reverse condition, whichever switch is turned off first cuts out the plate supply voltage.

MORRIS SUNTOP, Dev. Eng. Remington Rand, Utica, N. Y.

When connecting power, be sure "hot" lead is connected to indicator light side.



For etching and washing semiconductors . . .



B&A® "ELECTRONIC-GRADE" HYDROGEN PEROXIDE IS THE PUREST AVAILABLE!

Special, new B&A "Electronic-Grade" H_2O_2, 30% and 30% "stabilized"—with its stringent pH specifications—reduces variations in rate of etch . . . cuts down rejects and improves quality control in the production of semiconductors.

To eliminate another variable in the use of hydrogen peroxide for semiconductor production, Baker & Adamson® has now added label specifications for the pH of "Electronic-Grade" H_2O_2, 30% and 30% "stabilized" (see box). The pH for hydrogen peroxide, 30%, is 2.5-3.5 . . . for 30% "stabilized," 3.0-3.5.

These tight specifications provide still better control and uniformity of peroxide than in the past and eliminate variations from lot to lot. This is still another example of B&A's continuing leadership in supplying production chemicals of the highest purity and quality for the electronic industry. B&A "Electronic-Grade" Hydrogen Peroxide, 30%, is readily available in 1 lb. plastic bottles and 30-gallon polyethylene-lined drums. "Electronic-Grade" Hydrogen Peroxide, 30% "stabilized," comes in 1 lb. or 5 lb. glass bottles and in the 30-gallon drums.

Remember . . . for the purest hydrogen peroxide available . . . as well as for the highest quality in other electronic chemicals . . . specify B&A!

Check these stringent specifications

HYDROGEN PEROXIDE, 30% . . . CODE 2774
H_2O_2 M.W. 34.02

MEETS A. C. S. SPECIFICATIONS

Assay (H_2O_2)	29.0-32.0%
pH	2.5-3.5

MAXIMUM LIMITS OF IMPURITIES

Residue after Evaporation	0.002%
Free Acid (As H_2SO_4)	0.003%
Chloride (Cl)	0.0005%
Nitrate (NO_3)	0.0005%
Phosphate (PO_4)	0.00025%
Sulfate (SO_4)	0.0005%
Ammonium (NH_4)	0.0005%
Heavy Metals (as Pb)	0.0001%
Iron (Fe)	0.00005%

HYDROGEN PEROXIDE, 30% "STABILIZED" . . . CODE 2775
H_2O_2 M.W. 34.02

Assay (H_2O_2)	29.0-32.0%
pH	3.0-3.5

MAXIMUM LIMITS OF IMPURITIES

Residue after Evaporation	0.03%
Free Acid (as H_2SO_4)	0.005%
Chloride (Cl)	0.0005%
Phosphate (PO_4)	0.020%
Sulfate (SO_4)	0.001%
Heavy Metals (as Pb)	0.0001%
Iron (Fe)	0.00005%

HYDROGEN PEROXIDE, 3% SOLUTION . . . CODE 2773
H_2O_2 M.W. 34.02

Assay (H_2O_2)	3.0-3.5%

MAXIMUM LIMITS OF IMPURITIES

Residue after Evaporation	0.020%
Free Acid (as H_2SO_4)	0.010%
Chloride (Cl)	0.0005%
Nitrogen Compounds (as N)	0.005%
Phosphate (PO_4)	0.003%
Sulfate (SO_4)	0.005%
Arsenic (As)	0.00001%
Heavy Metals (as Pb)	0.0001%
Iron (Fe)	0.00005%
Preservative	0.035%

BAKER & ADAMSON®
"Electronic Grade" Chemicals

Allied Chemical

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

Circle 85 on Inquiry Card

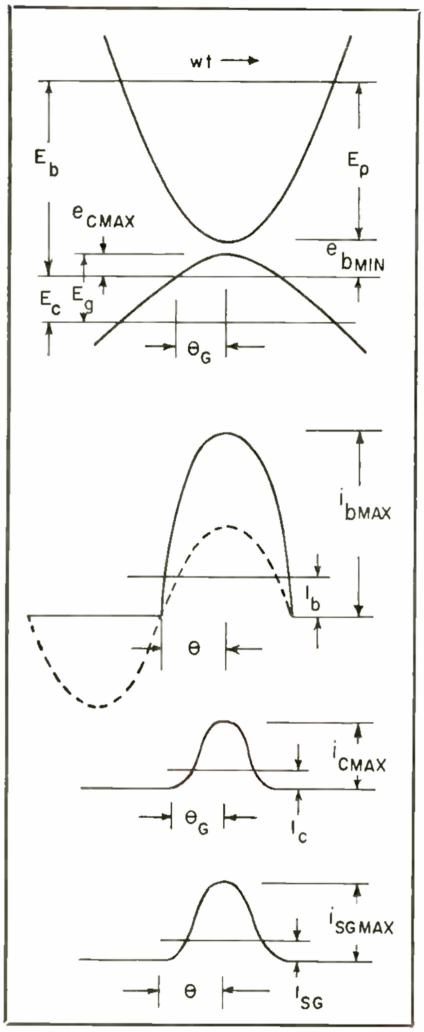


Fig. 1: Class C tube operation. The dotted curve in second group represents the fundamental frequency.

With these charts, the designer can see the effect upon the plate efficiency and current ratios when the shape or duration of the plate current pulse is changed. Amplifiers, doublers, and triplers are treated.

For Circuit Designers:

Charts Ease Amplifier Calculations

By ROY A. HENDERSON
Surface Communications
Defense Electronic Products
Radio Corp. of America
Camden, N. J.

THE charts provided here will facilitate the calculations of tube performance. They allow the designer to observe the effect upon the plate efficiency and the plate current ratios, when the duration or shape of the plate current pulse is altered.

Fig. 1 illustrates tube operation in a Class C amplifier. The grid is given enough negative bias voltage to prevent the flow of plate current. Then a cosine wave of r-f voltage is superimposed on the grid, so that the grid goes positive with respect to the cathode, for part of the r-f cycle. While the grid is in (or near) the positive region, plate current flows. The instantaneous value of the plate current is given in Eq. (5).

We are interested in the plate current pulse from three view points, as follows:

i_{bmax}=Plate current, max. value.

I_b=Plate current, ave. value.

I_{pm}=R-F current, peak value. For the Class C amplifier this will be the fundamental frequency value. The harmonic amplifier requires that the plate circuit be tuned to a harmonic of the radio frequency imposed upon the grid. For doublers and triplers, subscripts $_2$ and $_3$ respectively, are added to I_{pm} to identify these harmonic currents.

In general, I_{pm} should be high and I_b should be low for the best plate efficiency. They vary with the duration and shape of the plate current pulse.

The duration of the pulse, number of degrees from start to finish, is controlled by adjusting the values of bias voltage and r-f grid voltage. In this article, θ refers to one-half of this duration.

The shape of the plate current pulse is largely inherent in the tube characteristic. A measure of this shape is α, in Eq. (5). Traditionally, α is assumed to be three-halves (1.5) power. However, it varies with tube design.

In the solution of a specific problem, the 3 values of plate current listed must be determined. Initially, however, ratios of these 3 currents are very useful since the relationships can be plotted as general curves. We are interested in ratios i_{bmax}/I_b and I_{pm}/I_b.

Class C Amplifier

Wagener and Terman, have determined how changes in the shape and duration of the plate current pulse affect these plate current ratios. These are illustrated in separate sections of Fig. 2. In the lower right section, i_{bmax}/I_b is plotted against θ for various α values. In the upper right section, I_{pm}/I_b is plotted against the same θ abscissa, for various α values. The 2.5 values of α were calculated by the methods given in Ref. 7.

Abscissa designated 1—cos θ will be useful when grid voltage calculations are made.

Return for the moment to Fig. 1. The maximum value of plate current flows when the plate voltage is at its lowest value (e_{bmin}). The r-f voltage across the tuned circuit is a cosine wave; its peak value is E_p. We can express the plate power output as:

$$P_o = E_p \times I_{pm}/2 \qquad (1)$$

Therefore it is desirable for E_p to be large, and e_{bmin} to be small, to get maximum power output.

K Factor

Scott[3] introduced a factor K, which is the ratio of e_{bmin} *to* E_b, expressed in %. Then he gives the plate efficiency in the following simple terms:

$$\eta = [(100 - K)/2]\,(I_{pm}/I_b) \qquad (2)$$

He then plotted this relationship against θ and the current values, for $\alpha = 1$. His approach is so attractive that it is used in this article.

Eq. (2) is plotted in Fig. 2, in the upper left section. It shows that efficiency is increased when K is low and I_{pm}/I_b is high.

Now consider Fig. 2 as a whole. The 3 sections just described are complete in themselves, yet they are related. The first 2 sections have a common abscissa, θ, while the last section is related to the second one by a common ordinate I_{pm}/I_b. Therefore, Fig. 2 shows how efficiency changes as θ is varied. This is its primary function. It also gives the current ratios, of course. Once the parameters are determined, the relationship is very simple.

For example, suppose our chosen tube has the mean α value of 1.5. Suppose further that K can be 10. Now choose the efficiency you desire and read the desired unknowns. If we arbitrarily decide on 80% efficiency, project upwards to $K = 10$ and read $I_{pm}/I_b = 1.775$. Project to the right to $\alpha = 1.5$ and then downwards to $\theta = 70°$ and $1 - \cos\theta = 0.66$. Project further downwards to $\alpha = 1.5$, then project to the left and read $i_{bmax}/I_b = 4.5$.

Other Parameters

Now to discuss the remaining designations on Fig. 2. These are trial i_{bmax}/I_b, B parameters, and i_{sgmax}/I_{sg}.

Trial i_{bmax}/I_p is a device proposed in Ref. 4. Its value for an amplifier is 3.5, 4.0, and 4.5, for efficiencies of 70, 75, and 80%, respectively. The purpose of trial i_{bmax}—derived from this ratio—is to allow e_{bmin} to be determined on the first attempt, thus avoiding repeated juggling of the two values. Once e_{bmin} is fixed, K can be determined immediately. The above relationship can be summarized as

$$\text{Trial } i_{bmax}/I_b = 0.1\,(\eta - 35) \qquad (3)$$

It appears to work very well for many tubes. It is less accurate for flat-topped current pulses, however, tending to read high. The values are plotted on Fig. 2 for the designer's convenience, so that they may be read directly for any reasonable efficiency.

B parameter markings indicate a method of finding α, since the latter is not evident from tube characteristics. A simple and fast method is desired, one that involves very few points.

In the sampling system proposed here, the instantaneous plate current is determined at half grid

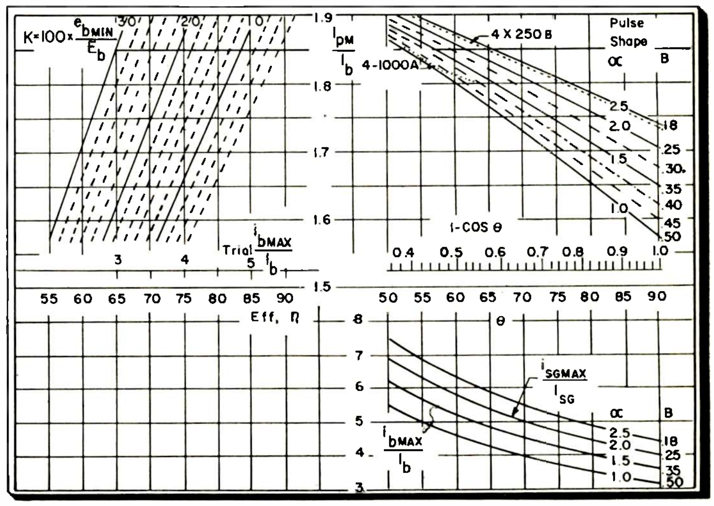
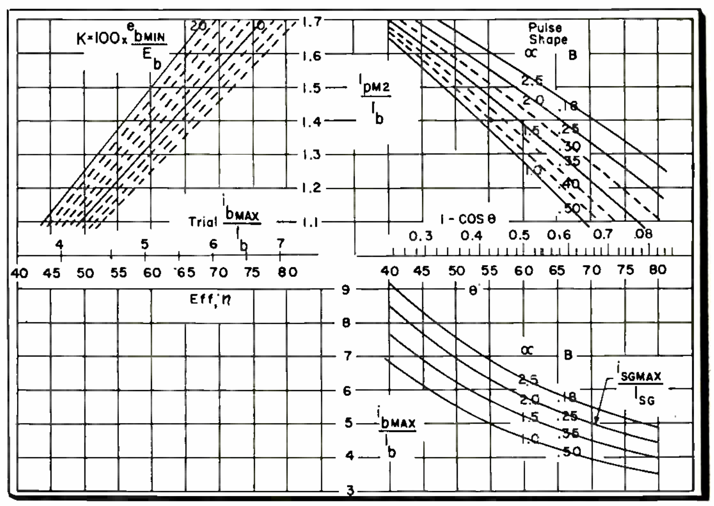


Fig. 2 (above): Charts used for the design of an amplifier.

Fig. 3 (below): These charts are used for doubler design.



Amplifier Charts

(Continued)

swing and also at full grid swing. For simplicity; θ is 90°, so one point on the load line is zero plate current at chosen E_b. The other end of the load line is i_{bmax} at e_{bmin}. This is demonstrated in Fig. 5 for the 4X250B tube. For the constant current curves, the load line need not be actually drawn; a decimal ruler or centimeter scale may be used to measure the distance between the points. The plate current at the center of this distance, $E_g/2$, can be readily determined. Then

$$B = (\text{plate current at } E_g/2)/(\text{trial } i_{bmax}) \qquad (4)$$

Wagener gives the instantaneous plate current as:

$$i = (\cos \omega t - \cos \theta)^{\alpha} \qquad (5)$$

where positive plate current flows each cycle between $\omega t = -\theta$ and $\omega t = +\theta$.2 Eq. (4) involves Eq. (5) in both numerator and denominator. Since θ is 90°, the second term of Eq. (5) disappears. Note that ωt is 60° in the numerator and 0° in the denominator. Hence:

$$B = (\cos 60°)^{\alpha} \qquad (6)$$

B equals 0.50 when α is 1, .25 when α is 2, etc. This relationship could have been plotted. To avoid this extra step, the parameters in Fig. 2 are identified with both α and B values. Therefore, α may be determined from the B value, if desired, or the chart may be entered directly with the known value of B.

In the Fig. 5 example, the load line lies between 0 amps at 2000 volts and 1.2 amps at 110 volts. At the mid-point of the grid swing, the current is 0.2 amps. Hence $B = 0.2/1.2 = -0.17$ approx.

If conventional tube curves are used for this sampling method the imaginary load line will be laid out in the same manner. The plate current should be read at one-half the grid swing, not at the center of the load line.

Accuracy

How accurate is this sampling method? In determining this, plate current pulses of the 4X250B and 4—1000A tubes were analyzed, using the computer in Ref. 8. These tubes were chosen because the pulses are so different, one being approximately sine-squared and the other having a flat top. Ratio I_{pm}/I_b was determined for various θ angles, and the results plotted as dotted curves in Fig. 2. The 4—1000A pulse changes its shape; it loses much of its flat top

Amplifier Procedure (Tetrodes, Pentodes, and Triodes) and Multiplier Procedure (Tetrodes & Pentodes.)

1. Determine E_b, E_{SG}, μ or μ_{SG}, P_o, η
2. $P_i = 100\, P_o/\eta$
3. $P_p = P_i - P_o$
4. $I_b = P_i/E_b$
5. Opposite η, read Trial $i_{b\,max}/I_b$. Trial $i_{b\,max} = I_b \times$ Trial $i_{b\,max}/I_b$
6. Determine $e_{b\,min}$ on tube curves. $K = 100 \times e_{b\,min}/E_b$
7. On curves, plot point at E_b and 0 amp., and at $e_{b\,min}$ and Trial $i_{b\,max}$. Read plate current i at $E_g/2$.
   $B = i$ at $(E_g/2)/$Trial $i_{b\,max}$
8. Apply K, η, and B to charts Fig. 2, 3, or 4.
   Read I_{pm}/I_b, θ, $1 - \cos\theta$.
   Read $i_{b\,max}/I_b$ and $i_{SG\,max}/I_{SG}$
9. $i_{b\,max} = I_b \times i_{b\,max}/I_b$
10. Apply $i_{b\,max}$ and $e_{b\,min}$ to curves.
    Read $e_{c\,max}$, $i_{c\,max}$, $i_{SG\,max}$

11A. $E_g = \dfrac{(\mu + 1)\, e_{c\,max}}{\mu\,(1 - \cos\theta)} + \dfrac{E_b}{\mu}$ Triode

11B. $E_g = \dfrac{e_{c\,max} + E_{SG}/\mu_{SG}}{1 - \cos\theta} \times 1.1$ Tetrode

12. $E_c = e_{c\,max} - E_g$

---

13. Calculate E_g/E_c
14. On Fig. 7, read $i_{c\,max}/I_c$
15. $I_c = i_{c\,max} / (i_{c\,max}/I_c)$
16. $P_d = 0.9\, E_g \times I_c$
17. $P_g = P_d + E_c \times I_c$
18. $I_{SG} = (i_{SG\,max}) / (i_{SG\,max}/I_{SG})$
19. $P_{SG} = E_{SG} \times I_{SG}$.

Multiplier Procedure (Triodes)—Same as above

except Replace step 11A with 11C (or with 11D & 11E). Replace step 12 with 12A

11C. $E_c = -\dfrac{E_b}{\mu}\left(\dfrac{1 - \cos N\theta}{1 - \cos\theta}\right) - e_{c\,max}\left(\dfrac{\cos\theta}{1 - \cos\theta}\right) - \dfrac{e_{b\,min}}{\mu}\left(\dfrac{\cos N\theta}{1 - \cos\theta}\right)$

where $N = 2$ for doubler and 3 for tripler. See Fig. 6 for ratios.

11D. $E_c = -\dfrac{E_b}{\mu}(4.9 - 0.033\,\theta) - e_{c\,max}\left(\dfrac{6480}{\theta^2} - 0.8\right)$ Approx. for Doubler.

11E. $E_c = -\dfrac{E_b}{\mu}(11 - 0.12\,\theta) - e_{c\,max}\left(\dfrac{6480}{\theta^2} - 0.8\right)$ Approx. for Tripler.

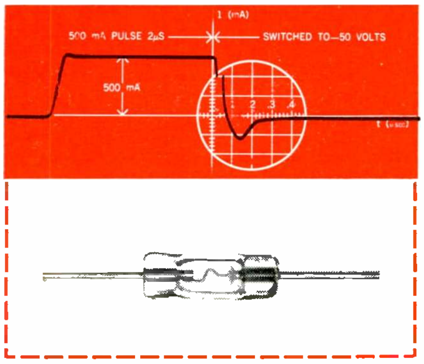
12A. $E_g = e_{c\,max} - E_c$

DEVELOPED BY SPERRY SEMICONDUCTOR . . .

PERFORMANCE PROVED IN

UNIVAC LARC

SOLID STATE COMPUTER



For the most advanced semiconductor devices in your computer applications—

SPECIFY SPERRY

HIGH-CURRENT FAST-SWITCHING SILICON DIODES

Ultra-high speed computing, 25 to 200 times faster than other existing computers, is an accomplished fact in Remington Rand's UNIVAC LARC—the most sophisticated of the new "second-generation" computers. Key to its unparalleled speed and reliability are the thousands of Sperry high-current fast-switching diodes built into its critical memory driving circuits.

Selected from Sperry's unique high-current silicon types, these were the only diodes in the industry able to meet the severe performance requirements of the LARC circuitry. Many Sperry computer diodes, such as the 1N690 and 1N691, are finding wide acceptance by the industry in more than a dozen other high speed computer prototypes.

SPERRY SEMICONDUCTOR DIVISION, *SPERRY RAND CORPORATION, SOUTH NORWALK, CONN.*
Regional Sales Offices: South Norwalk, Conn., New York, N. Y., Chicago, Ill., Los Angeles, Calif.

Amplifier Charts *(Continued)*

at low θ angles, where B is approx. 0.46. From 67° to 90° it lies on the $B = 0.4$ parameter, whereas the sampling method predicted that $B = .124/.268 = 0.46$. A plot of i_{bmax}/I_b vs. θ falls on the $B = 0.50$ parameter.

The 4X250B curve of I_{pm}/I_b vs. θ coincides with a B parameter of 0.19 approx., while the predicted B (from **Fig. 5**) is 0.17. A plot of i_{bmax}/I_b vs. θ varies from $B = 0.20$ (at 50°) to $B = 0.23$ (at 90°).

Ratio i_{sgmax}/I_{sg} is needed so that the average value of current can be calculated from the maximum value. Terman assumes that the screen current pulse is cosine-squared and that the flow angle is θ (same as the plate current). The latter assumption is a rough approximation, but it is accurate enough for most purposes. Therefore the plate current ratio, for α parameter of 2, also serves for the screen current ratio on Fig. 2.

Harmonic Amplifiers

Fig. 3 is drawn for a frequency doubler. It is quite similar to Fig. 2 except that the second harmonic component of I_{pm} is used in the ratio I_{pm}/I_b. It will be noted that, compared to **Fig. 2**, θ must be lowered to get reasonable efficiency (maximum values of I_{pm2}/I_b), and that the efficiency is lower.

In establishing trial i_{bmax}/I_b for this curve, the assumption is made that the highest and lowest efficiencies are approximately coincident with K values of 5 and 16, respectively. It was also assumed that trial i_{bmax}/I_b varies linearly with efficiency, over much of this range, as was the case in Fig. 2. Therefore, the linear part of this relationship can be expressed by:

$$\text{Trial } i_{bmax}/I_b = 0.1\ (\eta - 9) \qquad (7)$$

Fig. 4 is for a frequency tripler, otherwise it is similar to Figs. 2 and 3. Both θ and efficiency have been lowered to reasonable values for the I_{pm}/I_b obtainable. The latter is of course the third harmonic component.

The trial i_{bmax}/I_b is established on the same basis as for Fig. 3. The linear part is given by:

$$\text{Trial } i_{bmax}/I_b = 0.1\ (\eta + 13) \qquad (8)$$

Suggested Procedure

We like certain steps in Ref. 4, where a desired power output is chosen and θ is then determined. The same reference emphasizes that the calculations should be the basis of a single tube, where tubes are used in push-pull or in parallel. In the beginning, divide P_i, P_o, and P_p by the number of tubes. Afterward multiply I_b, I_c, I_{sg} and P_d by the number of tubes.

In determining the desired power output, the designer should make it high enough to include expected circuit losses. In the same manner, the calculated driving power should be increased by the grid circuit losses, when completed. For the special case of the grounded-grid amplifier, current I_{pm} flows in the driver circuit as well as in the output. Therefore, the driving stage must have capabilities of furnishing the additional power $E_g \times I_{pm}/2$. This same power adds to the output power.

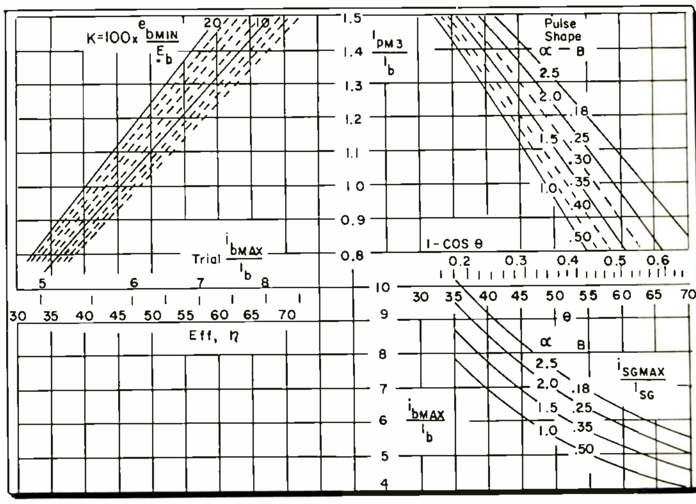
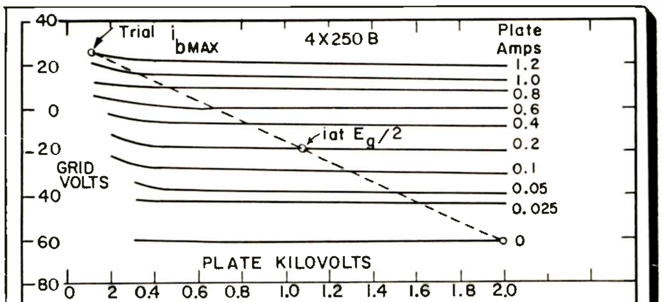


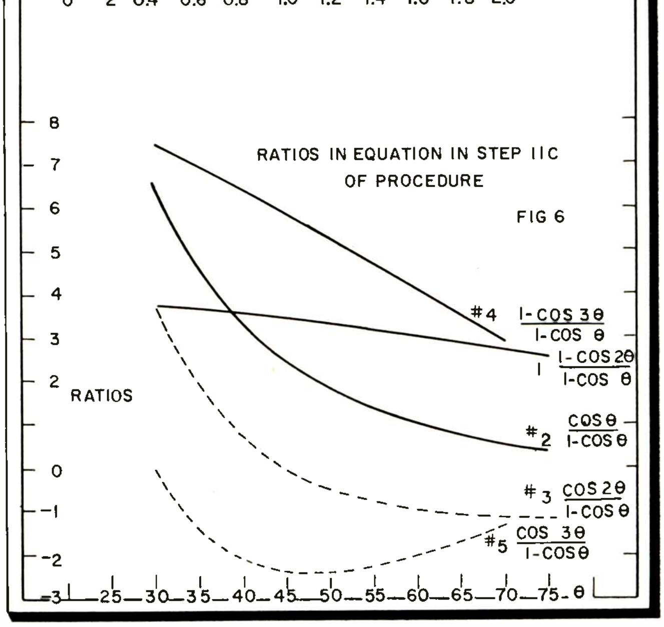
Fig. 4: Frequency tripler design is eased with this chart.

When applying trial I_{bmax} to the tube curves, there may be some question about locating e_{bmin}. The latter should be set nearly as low as possible. This point is reached on constant-current curves when the curves bend sharply upward, for the tetrode. It is where the constant plate current line crosses the diode line (line of equal plate and grid voltages) for the triode.

Fig. 5 (upper cut): Demonstration of the proposed sampling system.

Fig. 6 (lower cut): Ratios in equation in Step 11C of procedure.





In general, e_{bmin} may be set lower than E_{sg}, for the tetrode, providing the constant plate current curves do not bend sharply upwards, and providing screen grid current is not excessive. For the triode, e_{bmin} may be equal to—or slightly higher than—e_{cmax}, if the grid current is not excessive.

In some instances the load impedance, E_p/I_{pm}, may have to be lowered deliberately to meet bandwidth requirements, so e_{bmin} must be set well above the minimum value. Ratio K will be increased and the efficiency lowered. The K parameters in Fig. 2 have been plotted up to 30 to cover this contingency. The determination of trial i_{bmax}/I_b from Eq. (3) will not be valid, since we never expect the ratio to be less than 3.

At each step of the calculation, the result should be compared with the rated tube capability. Obviously the latter should not be exceeded.

Some of the procedure steps have been explained in the text. The derivation of equation, and an alternate procedure, are given in the Appendix.

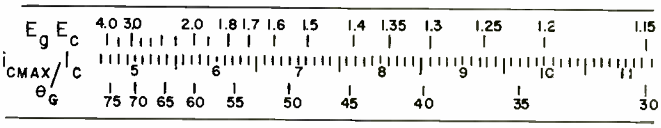


Fig. 7: Linear form of the plot which enables the known voltage ratio to be used to determine the current ratio.

References

1. W. G. Wagener, "Simplified Methods for Computing Performance of Transmitting Tubes," *Proceedings IRE*, Vol. 25, p. Jan., 1937.

2. F. E. Terman, *Electronic and Radio Engineering*, Fourth Edition, McGraw-Hill Book Co., Inc.

3. H. J. Scott, "A Note on Class C Power Amplifier Design," *Proceedings IRE*, Oct., 1952, p. 1250.

4. Application Bulletin #4, Eitel-McCullough Inc.

5. W. L. Everitt, *Communication Engineering*, McGraw-Hill Book Co., Inc.

6. E. E. Spitzer, "Simplifying the Calculation of Transmitting Triode Performance," *Ham Tips* (Radio Corporation of America), Nov.-Dec., 1948.

7. E. L. Chaffee, "A Simplified Harmonic Analysis," *Review of Scientific Instruments* 7, p 384, Oct., 1936.

8. Application Bulletin #5, Tube Performance Computed, Eitel-McCullough Inc.

APPENDIX

Further explanation of a few steps in the procedure is given below.

Step 11A

For the triode, Everitt's [5] equation rearranged is:

$$E_g = (\mu\, e_{c\,max} + e_{b\,min} \cos\theta) \,/\, [\mu\,(1 - \cos\theta)] + E_b / \mu \qquad (9)$$

In a well driven, triode amplifier, e_{cmax} and e_{bmin} are very nearly equal. Eq (9) may therefore be reduced to the approximate equation in Step 11A with very little error.

Step 11B

For the tetrode, Ref. 2 and 4 give:

$$E_c = 1 \,/\, (1 - \cos\theta)\; (- e_{c\,max} \cos\theta - E_{SG} / \mu_{SG}) \qquad (10)$$

Since this ignores the effect of the plate voltage swing, the bias voltages calculated thereby are often low. An analysis of six popular tetrodes shows the calculated bias to be 10% low on the average.

Substituting $E_o = e_{cmax} - E_g$ in Eq. (10).

$$E_o = (e_{c\,max} + E_{SG} / \mu_{SG}) \,/\, (1 - \cos\theta) \qquad (11)$$

This equation also often gives low answers, for the same reasons. Since excess drive is preferable to a shortage, an arbitrary multiplier of 1.1 has been used in Step 11B.

Step 11C

When the triode is used as a frequency multiplier, Terman gives the grid bias equation found in procedure Step 11C.

The cosine ratios given in the 3 terms of this equation are plotted against θ in Fig. 6. Curves 1, 2, and 3 are for the doubler, and 4, 2, and 5 are for the tripler. It will be noted that Curves 3 and 5 are usually negative.

Steps 11D and 11E

The equation in Step 11D has been devised for those who are interested in mathematical approximations. The third term in Eq. (11C) is small; it could be dropped without serious error. If, as an alternative, e_{bmin} is given a mean value of 0.1 E_b, then the first and third terms may be combined by adding algebraically one-tenth of Curve #3 readings to Curve #1 readings. The resulting curve, nearly a straight line between 50° and 80°, is closely duplicated by the expression $4.9 - 0.033\theta$. This is of the form $y = mx + b$. Curve #2 is closely duplicated by the expression $(6480/\theta^2) - 0.8$ over the range of 45° to 80°.

Eq. (11E) for the tripler was devised in the same way by merging one-tenth of Curve #5 readings with #4 readings. The expression $11 - 0.12\theta$ is accurate over the range of 45° to 65°.

Steps 13 and 14

Wagener points out that $\cos\theta_G = -E_c/E_g$. Refs. 4 and 6 plotted this relationship against the ratio i_{cmax}/I_c, so that the known voltage ratio could be used to determine the current ratio. This plot has been reproduced in linear form as Fig. 7 on the procedure sheet.

Alternate Procedure

If the designer prefers to choose values of θ and I_b and then determine the efficiency, this may also be done with the charts. The suggested procedure is:

A. Trial i_{bmax}/I_b. Read this where chosen θ crosses i_{bmax}/I_b *for* $\alpha = 1.5$. Calculate trial i_{bmax}.

B. Determine e_{bmin} and calculate K. (Step 6).

C. Find B value (Step 7 and Fig. 5).

D. Enter chart with known values of θ, B, and K. Read efficiency, I_{pm}/I_b and i_{bmax}/I_b for given B values, etc.

E. Follow Steps 9 through 19 thereafter.

Telemetering

(*Continued from page* 179)

ing assembly. Also, printed circuit techniques are appliable.

Recording devices

The recorder can take on a number of forms. For instance, it can be a box containing electrical-mechanical mechanisms capable of accepting a special card with electro-sensitive, Teledeltos, paper which is marked by a grid of dots in accordance with the binary information supplied to the recorder. Another system is one that will accept and punch the information on standard IBM cards. The system employed here is an array of neon lamps, as seen on the panels of high speed interval timers, which give a visual indication of the meter reading.

The electrical power is supplied by a battery in the portable recorder, the neon bub indicating unit. Hence, no voltage is applied to the system (drum pick-up units at the meter) until the recorder is plugged into the outdoor receptacle, and the power switch on the recorder is turned on.

EXTRA COPIES

A limited number of copies of the following articles from back issues of EI are available, free of charge. For copies write: Reader Service Dept. Electronic Industries, 56th & Chestnut Sts., Phila. 39, Pa.

From The January 1959 Issue:
"Wall Street Looks at the Electronic Industry."
"Focusing Traveling Wave Tubes."
"High Accuracy Time Interval Measurements."
"Diagnosing with Strain Gages."
"High Temperature Wire & Cable (Part 1 & part 2)."

From The February 1959 Issue:
"Thermistor Sensing Elements For —445° F."
"Some Survival Aspects of Space Travel."
"Unity-Gain Amplifiers Improve Operation."
"Understanding Zener Diodes."
"Circuit Losses In the Transistor AF Amplifier."
"Systems Designing Communication In Space (Part 1 & part 2)."

From The March 1959 Issue:
"Radiation Shielded Thermometer Design."
"Interference from the Ionosphere."
"Increasing the Input Impedance in Transistor Amplifiers & Appendix."
"Exploiting Other Communications Media & Appendix."
"How to Measure Wide B and Impedance."

From The April 1959 Issue:
"Designing RDF Antennas."
"Design and Build an Anechoic Chamber."
"Trig Eases Filter Calculations."
"Designing a Spectrum Analyzer."
"Tubes or Transistors"

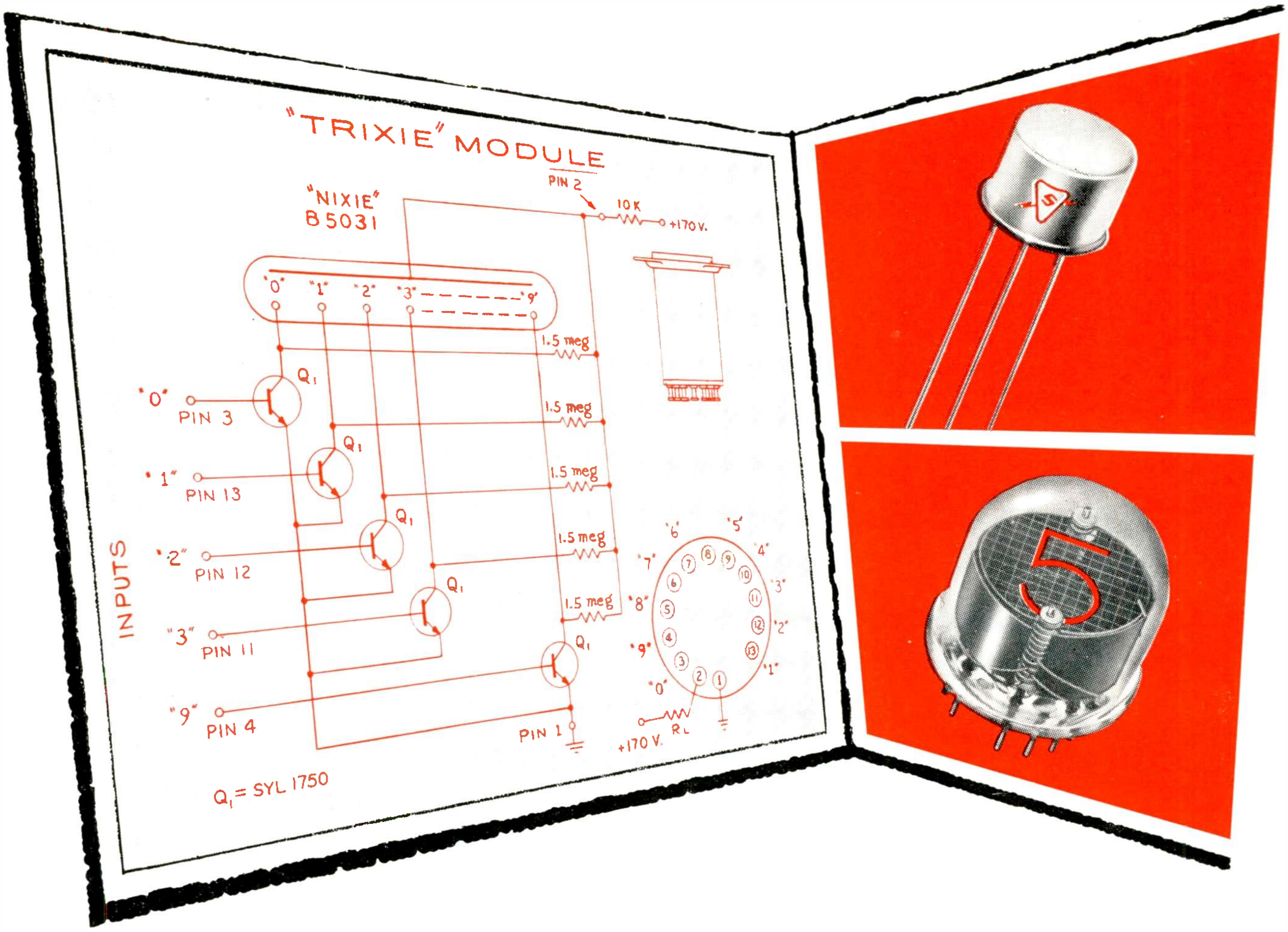
From The May 1959 Issue:
"Transistorizing a Flip-Flop."
"Thermal Stresses in Klystron Windows."
"High Brightness Radar Indicators."
"Designing Transistorized Video Amplifiers. (Part 1 & part 2.)"
"Planning Dynamic Reliability."

From The July 1959 Issue:
"Thermoelectricity—State of the Art."
"Remote Control by Near Magnetic Field."
"Components as Viewed by the Military Standardization."
"Systems Reliability—What it is and Why."
"Analyzing Networks with the Y-Matrix."
"Noise Parameters in VHF-UHF Circuit Design."

From The August 1959 Issue:
"Slightly Higher 'East of the Rockies'."
"Horizontal Deflection Switches."
"Why Do Companies Merge?"
"Asymptotes Solve Design Problems."
"A Novel Method for Frequency Multiplication."
"Analyzing Systems by Superposition."
"Improved Silicon Photovoltaic Cells."
"Tunnel Diode—New Electronic Work Horse."

From The September 1959 Issue:
"Flip-Flop Circuit Using Saturated Transistors."
"A Video Amplifier with a 30 MC Bandwidth."
"Cooling Power Transistors."
"Shrinking the Directional Coupler."

From The October 1959 Issue:
"DOPLOC Uses Phase-Locked Filter."
Thermistors 10° to 600° K.
"Shaft Angle Encoders Afford High Accuracy."
"Sensing RMS Values for Servo Systems."
"Transistorized Preamplifier Design."
"Dynamics of Relays. (Part 1 & part 2 & 3.)"



...NEW LOW-COST

Transistorized Readout

"Trixie", new computer readout circuit design, utilizes Sylvania's new NPN transistor, Syl 1750, and the Nixie® indicator tube

Now, designers can meet direct readout requirements for computers, instrumentation and data display with new economy and efficiency. Sylvania, pioneer manufacturer of NPN transistors, has developed new parameters in the Syl 1750 to meet the need for a low voltage input driving circuit for the Nixie indicator tube.

"Trixie" (Transistors + Nixie tube) comprises ten Sylvania NPN medium voltage switching transistors, Syl 1750, in a common emitter configuration. Each transistor drives one of the tube's ten cathodes. The result is the lowest power visual readout available. It can be designed in plug-in module form around a standard Nixie tube socket with terminals provided for electrical connections. A typical module, especially adaptable for direct panel mounting, has an over-all length of two inches and a nominal one-inch diameter.

The new Syl 1750, specially designed for "Trixie," is a 40 v (minimum) NPN germanium alloy junction transistor. Its low cost is a product of Sylvania's production know-how in NPN transistor manufacture and long experience in NPN design. Syl 1750 meets the reliability and performance criteria of other Sylvania switching transistors and matches their high-quality standards. It is encased in a JEDEC TO-5 package with the Sylvania welded hermetic seal for full protection against humidity and other environmental conditions.

Call your Sylvania representative now for full details of the new low-cost transistorized readout components.

"Trixie" & "Nixie" are trade marks owned by Burroughs Corporation.

SYLVANIA

Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

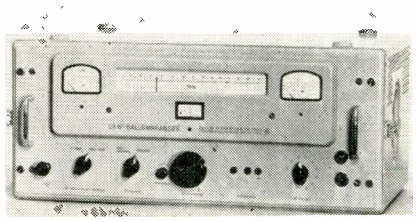
Sylvania Semiconductor Division
100 Sylvan Rd., Woburn. Mass.

Circle 93 on Inquiry Card

New Products

VHF-FM RECEIVER

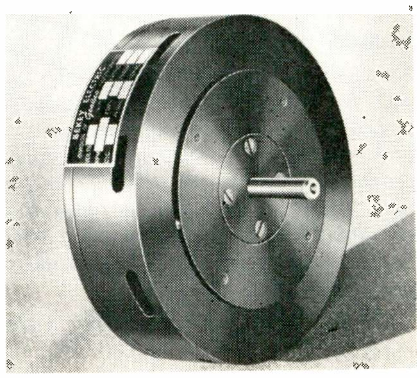
VHF-FM receiver for direct radio-relay broadcasting in FM-Networks picks up a program from the master transmitter and passes it on to a slave transmitter. Type ESB is available in 3 versions: relay receiver for broadcasting; long-distance link receiver for CF systems or transmission or radio programs over wide areas; short-distance link receiver for CF or radio relay links. Standard ESB types, frequency ranges (MC) include 87.5-100; 41-68; 60-88; 156-174; 174-220; 50-80. Maximum swing (kc) specs are: 50; 75; 150. Modulation frequencies are: 30-15,000 CPS, 300 CPS-60 KC; 300 CPS-120 KC. Rohde & Schwarz, Inc., P. O. Box 275, 111 Lexington Ave., Passaic, N. J.



Circle 166 on Inquiry Card

HYSTERESIS MOTORS

Hysteresis motor has high torque capabilities, fast acceleration and very good damping. Size of the new motor, the Bekey "Supersyn," in multipolar designs is a fraction of conventional multi-polar hysteresis motors. For example, a 12 pole "Supersyn" can be ¼th the size of a conventional hysteresis motor and develop the same output. Or, a 12-pole



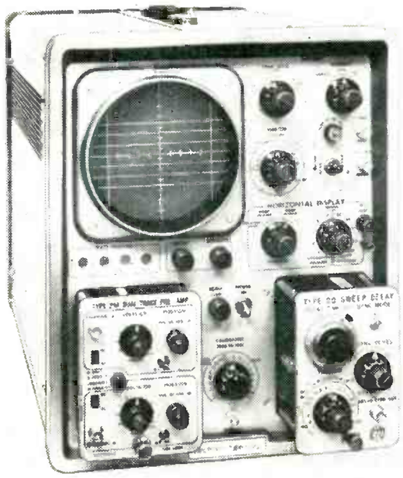
"Supersyn" hysteresis motor can develop 4 times more torque as a conventional hysteresis motor of the same physical size. Bekey Div., Genisco, Inc., 2233 Federal Ave., Los Angeles 64, Calif.

Circle 167 on Inquiry Card

New Products

WIDE-BAND OSCILLOSCOPE

The ETC Model K-120 features a wide-band vertical amplifier with 0.017 μsec rise time, sweep lock-out, beam position indicators, single knob calibrator and sweep controls, and

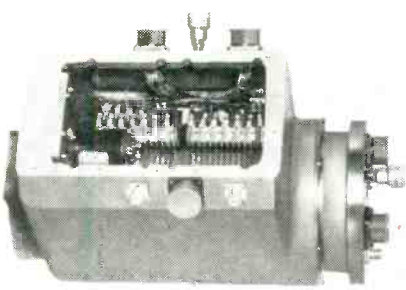


others that simplify operation and waveform analysis. In addition to a plug-in sweep delay, several plug-in pre-amplifiers are available. The dc to 20 MC, 0.05 v/cm Type 20A "Plug-in" serves the majority of single-channel applications. An electronic switch pre-amplifier "Plug-in"—Type 20B—is available for dual trace applications. Other pre-amplifier "Plug-ins" will be produced to meet specific needs. Electronic Tube Corp., 1200 E. Mermaid Lane, Philadelphia 18, Pa.

Circle 168 on Inquiry Card

SLIP RING ASSEMBLIES

Slip ring assemblies, 38 in number, are components in radar rotating antenna circuits. Each unit includes two coaxial, seven shielded circuits, and 47 unshielded circuits. Dimensions are 24 x 12 x 12 in. The 56



rings are of coin silver, two silver graphite brushes per ring. Speed—15 rpm. Noise level below 0.002 volts. Superior Carbon Products, Inc., 9115 George Avenue, Cleveland 5, Ohio.

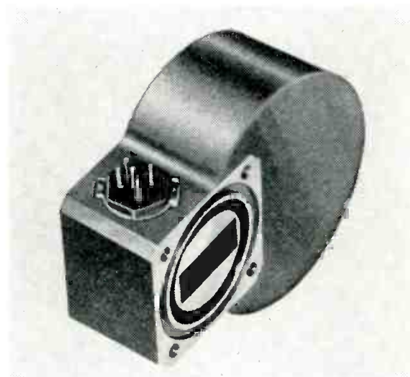
Circle 169 on Inquiry Card

Circle 95 on Inquiry Card

New Products

FERRITE SHUTTER SWITCH

Bilateral H-Plane Ferrite Switch, Model No. W574-1A-1, is for use in monopulse and doppler radar systems, surveillance and fire control systems. There are no moving parts.



It may be used as a shutter or switch element. Featured are: Frequency Range 13.5 KMC ±15 MC; Isolation at 25 db min.; Insertion Loss is indicated at 0.3 db max.; Input VSWR Transmit is 1.10 max. at center frequency; Input VSWR Reject 30:1; Rise Time at 100 μsec max.; Control Coil Power at 2 w max. Ambient temperature 85°C to 105°C. Kearfott Co., Inc., Microwave Div., 14844 Oxnard St., Van Nuys, Calif.

Circle 170 on Inquiry Card

TURNTABLE

All transistorized, 68-lb., portable unit is designed for hi-fidelity program origination in remote broadcasting. For use at fairs, supermarket openings, "disc jockey hops," and other events, the portable Announcer is small enough to slide into the rear seat of a standard automobile. Self storing legs detach and fit into the

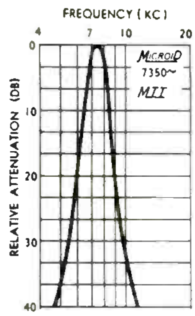
cabinet. Once on location, plugged in, and connected to a remote line the Announcer is ready for immediate use. Collins Radio Company, P. O. Box 1891, Dallas, Texas.

Circle 171 on Inquiry Card

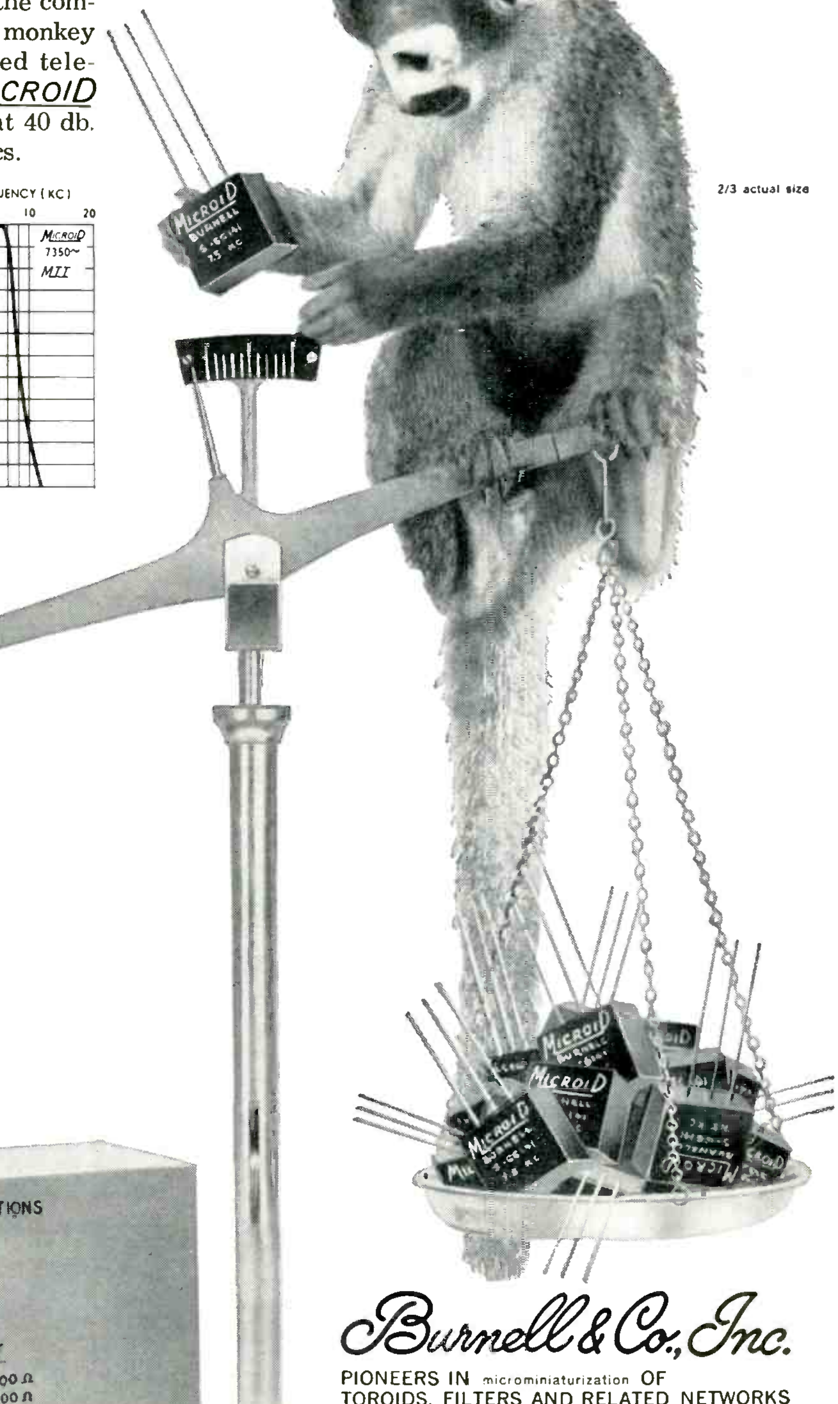
SPACE SHRINKERS

MICROIDS AND MONKEYS-- Burnell & Co. welcomes the assistance of their simian friends in the task of gathering data vital to space shrinking. By shrinking toroids, filters and related networks for guidance and communication systems, Burnell helps space vehicles carry bigger payloads — more instrumentation, animals — eventually man. Typical of our accomplishments is the MTT MICROID® telemetering band pass filter. Significantly, the combined weight of 23 MICROIDS — plus the monkey — is less than the single non-miniaturized telemetering band pass filter pictured here. MICROID band width is 15% at 3 db + 60% —40% at 40 db. Frequency coverage is from .4 kcs to 70 kcs.

	Sizes
Channels 1-6	2x27/32x1/2
Channels 7-10	1-5/16x11/16x11/16
Channels 11-18	15/16x19/32x1/2
Alternates A-E	15/16x19/32x1/2



Write for Filter Bulletin MTT 23.



2/3 actual size

Burnell & Co., Inc.

PIONEERS IN microminiaturization OF TOROIDS, FILTERS AND RELATED NETWORKS

EASTERN DIVISION
DEPT. I-24
10 PELHAM PARKWAY
PELHAM, N. Y.
PELHAM 8-5000
TELETYPE PELHAM 3633

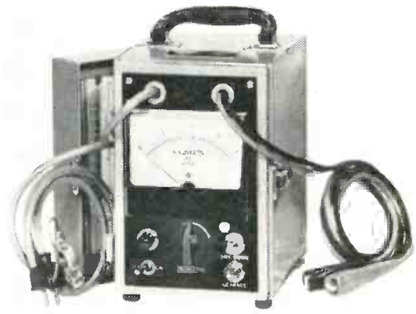
PACIFIC DIVISION
DEPT. I-24
720 MISSION ST.
SOUTH PASADENA, CAL.
RYAN 1-2841
TELETYPE: PASACAL 7578

Circle 97 on Inquiry Card

New Products

INSULATION TESTER

Portable isolation breakdown testers feature an automatic "Squawker" that sounds at preset leakage current values. The Series 4003 "Squawker" HYPOT[R] Jr. models are also equipped



with an adjustable limit, visual leakage current-indicator. Models with the "Squawker" audible indicator are available with ac test potential output up to 6000 v. The visual and audible leakage indicators have an adjustment range from 300 μa to 3 ma as standard and to 10 ma on special order. Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill.

Circle 172 on Inquiry Card

TEFLON TERMINAL

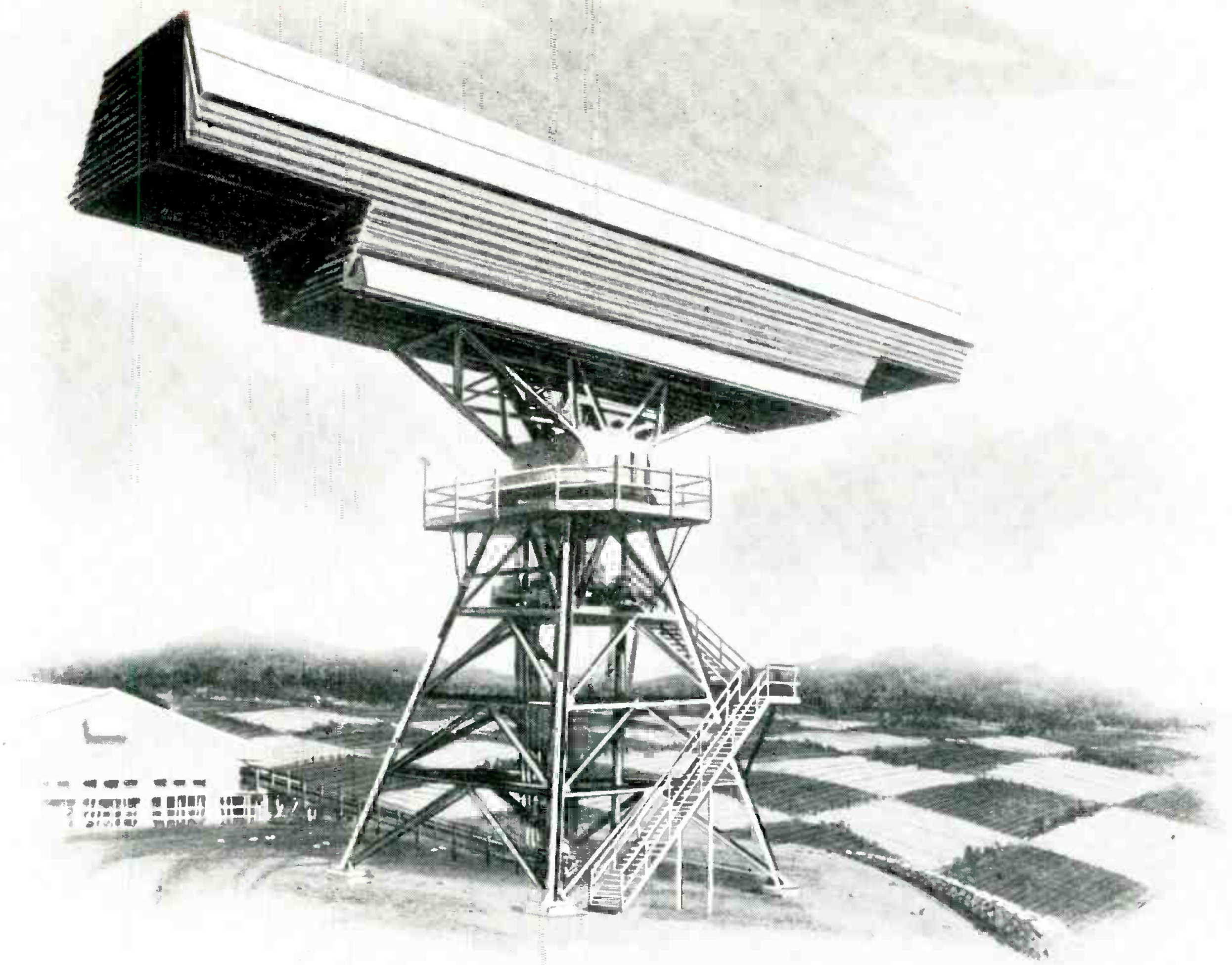
Type RFT-SM-2 TUR-C4, "Press-Fit" Teflon terminal line complements the reverse turret seed-thru terminals with a longer Teflon body, for installation in chassis up to 0.125 in.

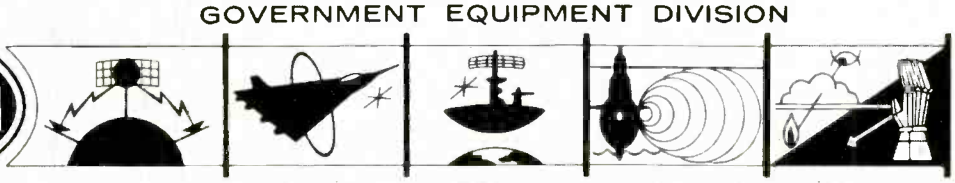
Retains advantages of "Press-Fit" one-piece construction that eliminates nuts, washers, lockwashers, etc., together with the insulating characteristics of Teflon. Sealectro Corp., 139 Hoyt Street, Mamaroneck, New York.

Circle 173 on Inquiry Card

Circle 98 on Inquiry Card

Circle 501 on "Opportunities" Inquiry Card ⟶





New Products

COAXIAL ATTENUATOR

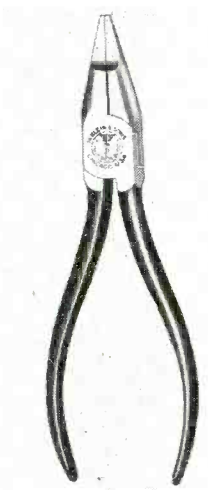
Flat coaxial attenuator, covers wide band widths, with flat attenuation vs frequency continuously adjustable attenuation and essentially zero insertion loss. Featured are: panel mount-

ing; in-line shaft adjustment; and direct reading, calibrated dial. Specs include: frequency band, available band widths from 4-7 to 7-11 KMC; attenuation variation with frequency less than ±5% expressed in db; VSWR on all settings less than 1.5; power handling capacity, 4 w; designed to produce a max. 40 db attenuation. Merrimac Research and Development, Inc., 584 Washington Ave., Belleville, N. J.

Circle 174 on Inquiry Card

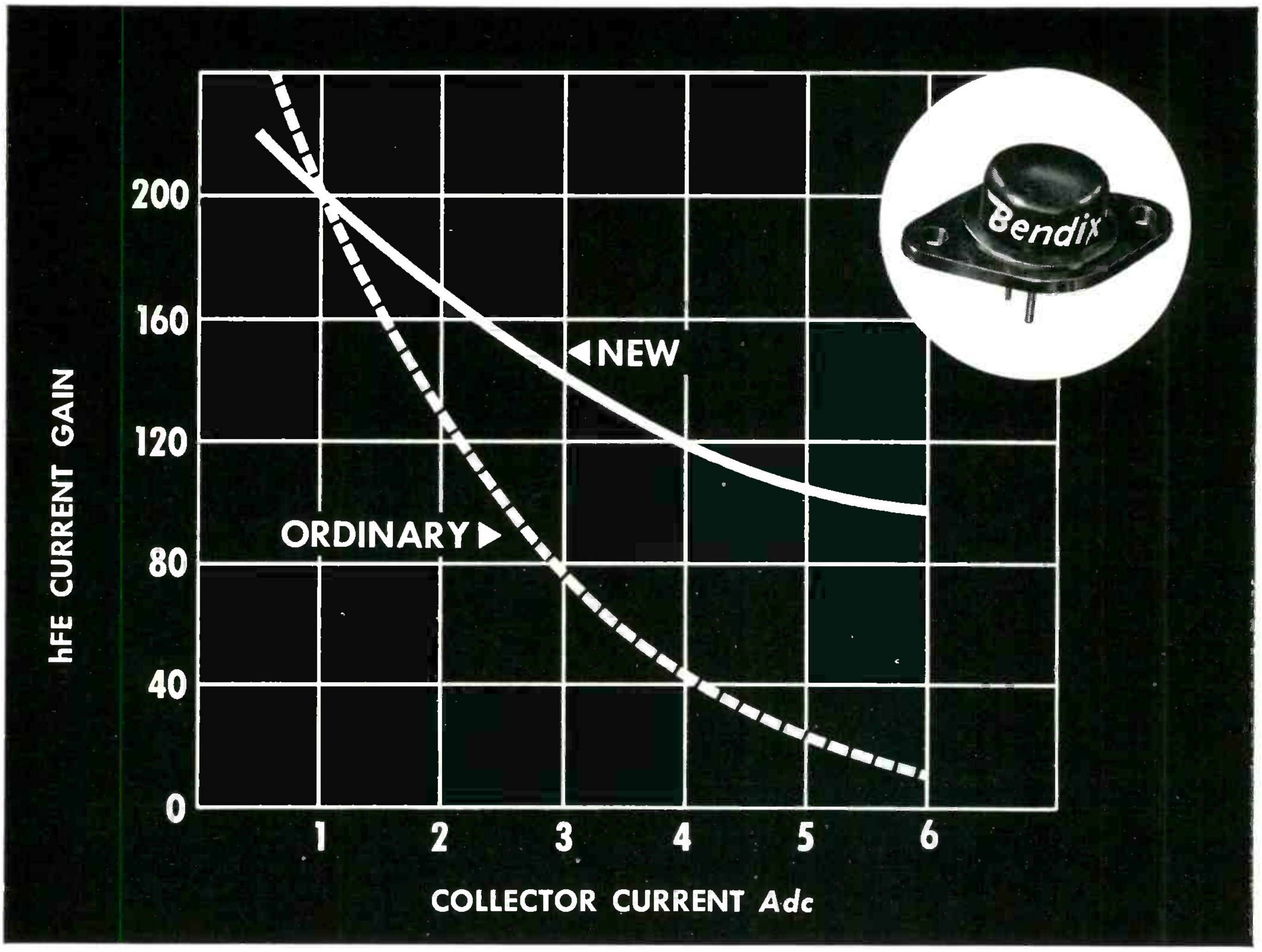
INSULATION SKINNER

Special plier is designed for telephone or electronic use. The plier will skin 22- or 24-gauge wire. Insulation is cracked in a special slot



provided in the nose of the plier. Catalog No. is 2291. Length is 6 inches. Mathias Klein & Sons, 7200 McCormick Road, Chicago 45, Illinois.

Circle 175 on Inquiry Card



Solid line indicates the low beta fall-off of one of the new Bendix transistors as compared to that of an ordinary transistor.

NEW BENDIX HIGH GAIN INDUSTRIAL POWER TRANSISTORS OFFER FLATTEST BETA CURVE

Now available—a new series of power transistors with the flattest beta curve in the industry, made possible by an exclusive Bendix process. This new series has very high current gains—up to 200 at 3 Adc—and a 10-ampere peak current rating.

Featuring ten-amp performance at a five-amp price, the 2N1136, A, B; 2N1137, A, B; and 2N1138, A, B series provide:

LOW BETA FALL-OFF → LESS DRIVE AND LESS DISTORTION
LOW SATURATION RESISTANCE → GREATER CIRCUIT EFFICIENCY
VOLTAGE BREAKDOWN RATINGS → ELIMINATION OF BURN-OUT
CURRENT GAIN MATCHING → OPTIMUM CIRCUIT PERFORMANCE

Ideally suited for use in static converters and regulators, these power transistors also have numerous applications in relay replacements and drivers for relays, magnetic clutches, solenoids and other loads requiring high current. In addition, their extremely high current gain and excellent hFE linearity make them practical and efficient television vertical output amplifiers and hi-fi amplifiers.

Current Gain hFE at Ic = 3 Adc	Maximum Voltage Rating		
	Vcb 60	Vcb 90	Vcb 100
	Vce 40	Vce 70	Vce 80
50-100	2N1136	2N1136A	2N1136B
75-150	2N1137	2N1137A	2N1137B
100-200	2N1138	2N1138A	2N1138B

For complete information, contact SEMICONDUCTOR PRODUCTS, BENDIX AVIATION CORPORATION, LONG BRANCH, NEW JERSEY, or the nearest sales office.

West Coast Sales Office: 117 E. Providencia Avenue, Burbank, California
Midwest Sales Office: 4104 N. Harlem Avenue, Chicago 34, Illinois
New England Sales Office: 4 Lloyd Road, Tewksbury, Massachusetts
Export Sales Office:
Bendix International Division, 205 E. 42nd Street, New York 17, New York
Canadian Affiliate:
Computing Devices of Canada, Ltd., P. O. Box 508, Ottawa 4, Ontario, Canada

SEMICONDUCTOR PRODUCTS
Red Bank Division
LONG BRANCH, N. J.

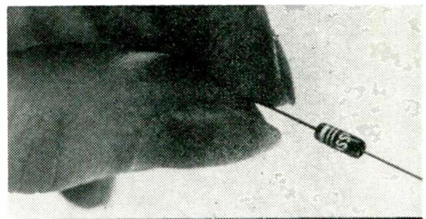
Bendix AVIATION CORPORATION

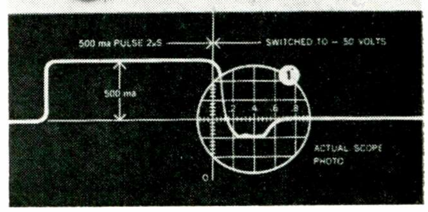
Circle 100 on Inquiry Card

New Products

SILICON DIODES

Series of high-current, high speed silicon switching diodes in 4 voltages, Series 1N690-1N693 diodes effect 0.8 μsec switching of ½ a pulses. For operation from −65 to +150°C, they feature high forward conduct-



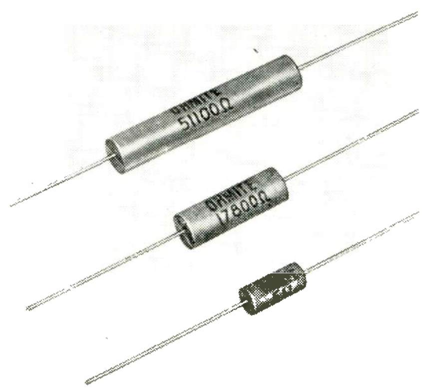


ance (400 ma at 1 v.) and low leakage (50 μa at 150°C). Units feature a max. recovery time of 0.8 μsec to return to 10K ohms when switched from a forward current 2 μsec pulse of 500 ma to a reverse voltage of −50 v., with a loop impedance of 1K ohm. Typically, they switch from a 5 ma forward pulse to −40 v. (−30 v. for 1N690 diode) and recover to 100K ohms in 0.5 μsec. (R_L = 2k, C_L = 10 μμf). Sperry Semiconductor Div., Sperry Rand Corp., So. Norwalk, Conn.

Circle 164 on Inquiry Card

WIRE-WOUND RESISTORS

Molded Wire-Wound Resistors in precision tolerances rated at 25°C are 3, 5, and 10 w. At 200°C ratings are still 1, 1.5, and 3 w respectively. Meet MIL-R-9444. Exhibit stability



of resistance and temperature coefficient of 275°C at the max. operating temp. of 275°C. Units pass the 1000-volt V-block test of MIL-R-26C. Ohmite Manufacturing Co., 3657 Howard St., Skokie, Illinois.

Circle 165 on Inquiry Card

GUARANTEED PERMEABILITY OF MOLY PERMALLOY...

at values higher than old average specifications

Molybdenum Permalloy nickel-iron strip is now available from Allegheny Ludlum with *guaranteed* permeability values. And the new guarantees are much higher than the old typical values. This exceptionally high quality means absolute uniformity for the user—new consistency and predictability for magnetic core performance.

Improved permeability of A-L Moly Permalloy is the result of Allegheny's program of production research on nickel-bearing electrical alloys. A similar improvement has been made in AL-4750 strip steel. Research is continuing on silicon steels including A-L's famous Silectron (grain oriented silicon steel), plus other magnetic alloys.

Another plus in dealing with Allegheny Ludlum is the operation of complete lamination fabrication and heat treatment facilities. A-L's years of experience in producing quality laminations result in practical know-how in solving problems common to core materials.

This working knowledge is available to all. Give us a call for prompt technical assistance on *any* problem involving electrical steels, laminations, or magnetic materials. Write for more information on A-L Moly Permalloy. *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address Dept. EI-24.*

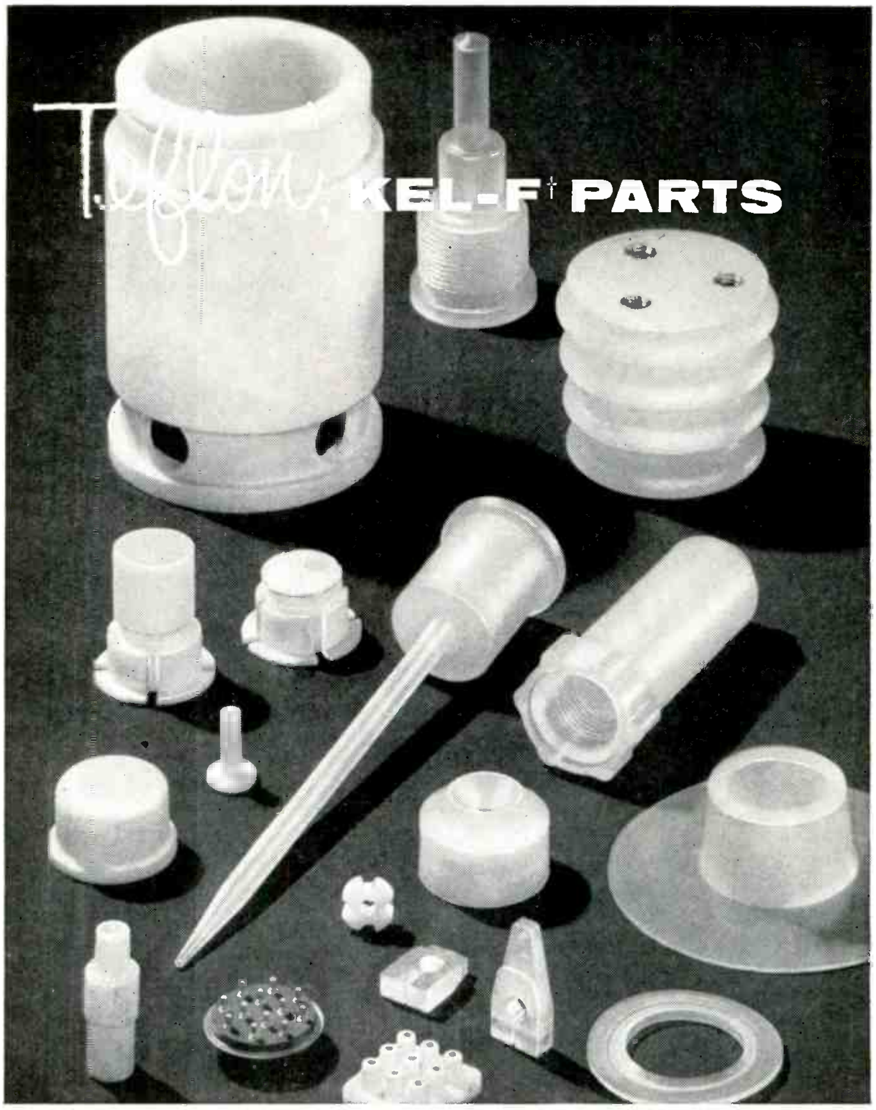
WSW 7273

ALLEGHENY LUDLUM

STEELMAKERS TO THE ELECTRICAL INDUSTRY

Export distribution, Electrical Materials: AIRCO INTERNATIONAL INC., NYC 17
Export distribution, Laminations: AD. AURIEMA, NYC 4

Circle 102 on Inquiry Card



THE *DIFFERENCE* IS IN THE MAKING

Good quality fluorocarbon parts require special processing techniques. This is why Garlock's United States Gasket Plastics Division is called upon so often to fabricate parts of fluorocarbon plastics. They have the personnel, the facilities, and unequalled experience in handling TEFLON and KEL-F. They specialize in precision molding and machining where close tolerances, intricate shapes, delicate wall sections, inserts, molding around metal, and threaded parts are involved.

If you have a difficult fluorocarbon problem, why not send it to your local Garlock office for quotation? Guarantee yourself the best in parts, methods, and price.

United States Gasket

For Prompt Service, contact one of our 26 sales offices and warehouses throughout the U.S. and Canada, or write The Garlock Packing Company, Palmyra, New York.

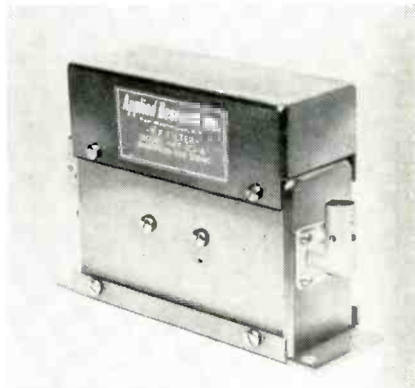
*DuPont Trademark
†M.M.&M. Trademark

Plastics Division of **GARLOCK**

New Products

BANDPASS FILTERS

Family of bandpass filters (Model HFF(C)—) operate from 300 to 1000 MC, operate from a 50-ohm and into a 50-ohm impedance, and have a skirt selectivity ratio of less than 3 to 1.



They are aligned to obey the Butterworth condition, and have a low insertion loss. Typical unit operates at 332 MC with 3 db bandwidth of 24 MC. With this center frequency, weight of the filter is 20 ounces. Dimensions are 5⅛ in. x 1 11/16 in. x 3¼ in. Applied Research Inc., 76 South Bayles Ave., Port Washington, N. Y.

Circle 162 on Inquiry Card

MINIATURE FUSE

Subminiature fuse, "Microfuse," measures 0.205 in. diameter x 0.270 in. long. Blowing specs are: Life—100% of rating; 0-10 seconds—150% of rating. The devices are available in either pigtail variety, which is especially adaptable for soldered connections, or in the plug-in variety,

which is designed to plug into a special sub-miniature fuse holder for chassis or printed circuit board mounting. Littlefuse, Inc., Des Plaines, Illinois.

Circle 163 on Inquiry Card

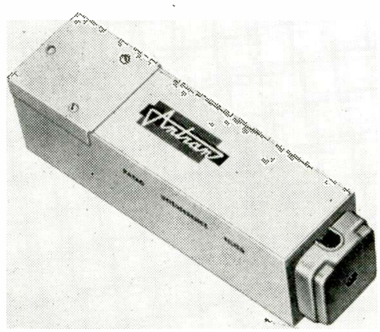
Circle 90 on Inquiry Card

Circle 91 on Inquiry Card →

New Products

TELEPHONE LINE FILTER

Filter allows use of telephones and intercoms in screen rooms without introducing interference. The 600-ohm impedance matches that of the telephone line. Unit has a telephone

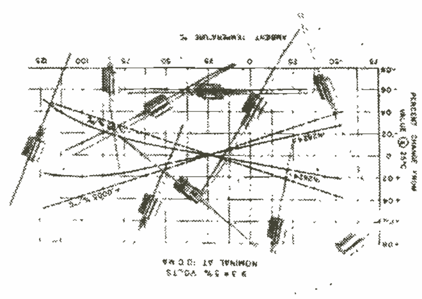


connector block for wiring to telephone lines. A balanced filter, it can be employed for any audio purpose. Filter is rated at 0.5 a.; 30 v.; 0 to 60 CFS. Resistance: 12 ohms, size: 8¾ in. long x 2½ in. square. Antran Div., International Electronics Mfg. Co., 2nd St. Extended, Greenwood Acres, Annapolis, Md.

Circle 220 on Inquiry Card

REFERENCE DIODES

Temperature compensated Zener reference diodes in an axial-lead, flangeless package measures approx. ¼ x ⅓ in. They will serve as a stable 9.3 v. reference source over

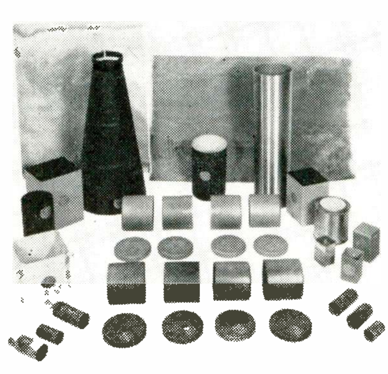


temp. of 0 to +75°C, −55 to +100°C and −55 to +150°C. Available in types 1N2620 through 1N2624, they have temp. coefficients of 0.01, 0.005, 0.002, 0.001 and 0.0005% per degree C. At 10 ma they have a dynamic impedance of 15 ohms max. Motorola Inc., Semiconductor Products Div., 5005 E. McDowell Rd., Phoenix, Ariz.

Circle 222 on Inquiry Card

SHIELDING KITS

Series of laboratory evaluation magnetic shielding kits for on-the-spot evaluation of non-shock sensitive, non-retentive Netic and Co-Netic shielding materials. They permit the design engineer to evaluate how many layers of materials are needed, what configuration, etc., to



solve his particular problem, without waiting. There are 5 kits in the series. Magnetic Shield Division Perfection Mica Company, 1322 No. Elston Avenue, Chicago 22, Illinois.

Circle 221 on Inquiry Card

RELAY ACTUATOR

Relay Actuator, senses the magnetic field created by current in a wire placed through a hole in the toroid. It can give relay actuation as low as 4.5 a., depending on the characteristics of the relay. It has no moving parts, eliminates mechanical timers normally used in such applications as welding,

and has no upper current limitations. This unit can be used for ac and dc systems. The toroid is enclosed in an epoxy material. L and B Electronics, 2424 Sixth St., Berkeley, Calif.

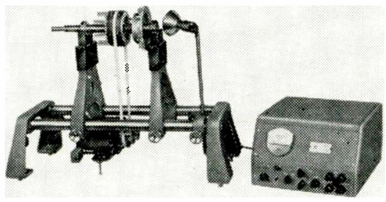
Circle 223 on Inquiry Card

Circle 105 on Inquiry Card

New Products

DYNAMIC BALANCER

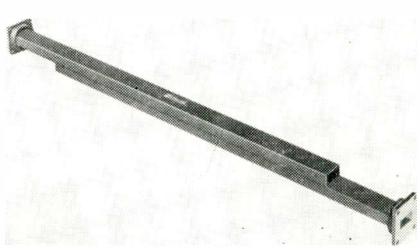
High sensitivity bench model dynamic balancer uses a seismic velocity type pick-up to assure rugged, maintenance free operation. The MU-6 has a weight handling range of 4 oz. to 100 lbs., as well as a wide range of operating-balancing speeds. It is suitable for nearly every type of rotor up to a maximum diameter of 24 inches . . . fans, armatures, blowers, pulleys, crankshafts, propellers, impellers, etc. Micro Balancing, Inc., Garden City Park, New York.



Circle 224 on Inquiry Card

WAVEGUIDE ATTENUATORS

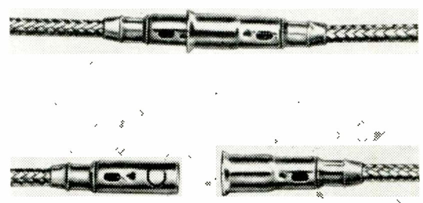
Precision, fixed, waveguide attenuators give broadband accuracy and eliminate using resistive devices as the attenuating element. Variation in attenuation from the nominal value is held to within ±0.5 db across the complete waveguide frequency band with a maximum VSWR of 1.05. Precision terminations are used in both sides of the unit to absorb the unwanted power in the input line and any reflections which are present in the output line. It is bilaterally matched and can be used in either direction. Models are offered with attenuation values of 10, 20, or 30 db. Waveline Inc., Caldwell, N. J.



Circle 225 on Inquiry Card

CABLE DISCONNECTS

Coaxial and shielded cable disconnect, has been expanded to fit a wider range of cable sizes. The unit fits all cables up to ¼ in. O. D. Interchangeable contacts permit a greater variation of inner conductor diameters in each size—solid or stranded. Application requires one crimp for complete assembly. A-MP Coaxicon is designed for RG Coaxial Cable, standard Coaxial Cable and other shielded cable types. AMP, Inc., Harrisburg, Pa.

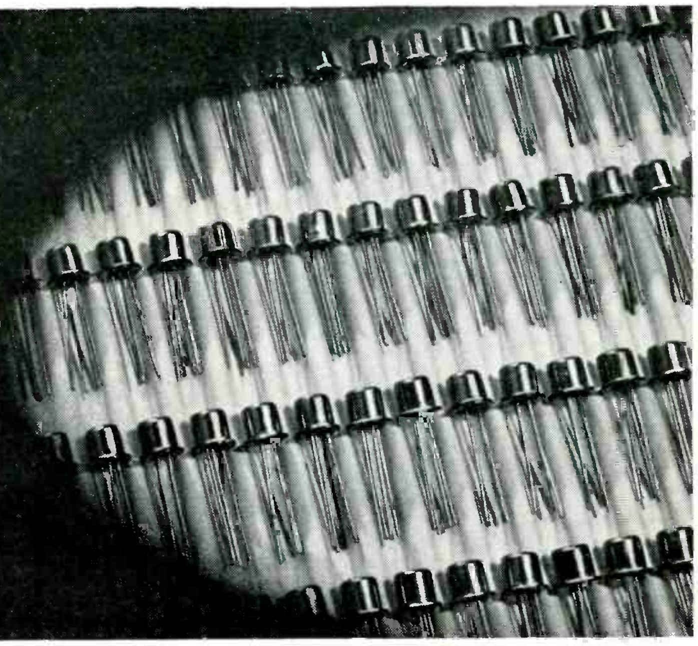


Circle 226 on Inquiry Card

! MORE !

The New Products mentioned here have been selected for contribution to or advancement of the electronic industries. These items are combed from several hundred new product releases received during the past month by ELECTRONIC INDUSTRIES. To keep interested readers informed of all new developments, a summary record is kept of ALL new products received. For a copy of this month's list, please send your request on company letterhead to Readers' Service Dept., Electronic Industries, 56th & Chestnut Sts., Phila., Penna.

for applications to 1000 mc the 2N700



MOTOROLA  MESA TRANSISTOR

major price reductions make many VHF/UHF applications practical

2N700 FEATURES

$f_{osc\,(max)}$	1000 mc
PG (neut.)	14 db @ 200 mc

- **High Temperature Operation.** All units baked-out under high vacuum at 200°C and stabilized at 100°C for 168 hours. Each lot must pass life tests of 1000 hours at 100°C. Units are rated for operation at 100°C.
- **High Efficiency.** A highly efficient oscillator, some points on the 2N700 efficiency-frequency curve are:

Frequency	Efficiency
40 mc	80%
100 mc	62%
200 mc	44%
400 mc	20%

- **Uniformity.** The Motorola Mesas are unquestionably the most uniform transistors available. Instead of the usual "selection process," closely controlled diffusion, etching and evaporative techniques enable Motorola to produce the Mesas to exact specifications. Such uniformity enables the engineer to tighten circuit tolerances, provide improved performance and simplify circuit design. It eliminates concern for variations in such factors as breakdown voltage, current handling capacity, frequency parameters, switching characteristics and saturation resistance.
- **Reliability.** 5,000 hour data on units tested at 100°C show the Motorola Mesa to be the most reliable transistor yet available.
- **Economy.** As the result of major price reductions, the 2N700 is an economical unit for VHF and UHF applications. In addition, fewer units are required on an overall circuit basis because of excellent performance characteristics.
- **Availability.** Engineering quantities are in stock at all 22 Motorola Semiconductor distributors. Production quantities shipped immediately from Phoenix.

Communications Equipment — Because of its small size, the Motorola 2N700 is ideal for low current, compact, highly reliable communications equipment.

IF Strips in Radar Gear — Offering greater gain per stage in its frequency range than any transistor available, the Motorola 2N700 is ideal for radar IF strips in the 60 mc range.

Parametric Amplifier Pump — The 2N700 makes an excellent source of pump power at the frequencies used.

Precision Oscillators — With stability in the order of 10^{-7} to 10^{-8}, the 2N700 is ideal for use in precision oscillators for single sideband and other communication equipment. It also has low phase shift and high loop gain. The 2N700 offers the uniformity and stability important for compact, lightweight precision equipment and instruments.

Oscilloscope Amplifiers — Ideal for instrument probes such as those used to provide preamplification for high speed, high frequency amplifiers.

Fixed IF Strips — Because of its extreme uniformity in all operating characteristics, the 2N700 could be designed into fixed-tuned IF strips, using toroid coils . . . greatly reducing IF strip size and eliminating large tunable elements and alignment problems.

Telemetering — 2N700 operating characteristics are ideal for telemetering applications in the 200 mc band. Its ruggedness (withstands 20,000g's) suggests application in telemetering transmitters fixed to high speed rotating equipment.

FOR COMPLETE SPECIFICATIONS AND DESIGN CONSIDERATIONS
on the 2N700 and the 2N695 (world's fastest switching transistor) contact your nearest Motorola Semiconductor regional office.

"DEPENDABLE QUALITY-IN QUANTITY"

MOTOROLA SEMICONDUCTORS

REGIONAL OFFICES:

RIDGEFIELD, NEW JERSEY
540 Bergen Boulevard
WHitney 5-7500
from New York WI 7-2980

CHICAGO 39, ILLINOIS
5234 West Diversey Avenue
AVenue 2-4300

HOLLYWOOD 28, CALIFORNIA
1741 Ivar Avenue
HOllywood 2-0821

Outside the USA and Canada:
MOTOROLA INTERNATIONAL, S.A.
4545 West Augusta Blvd.
Chicago, Illinois

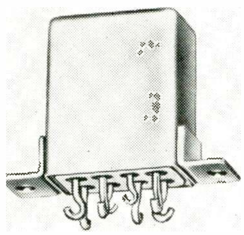
MOTOROLA, INC., 5005 E. McDOWELL, PHOENIX, ARIZONA

Circle 107 on Inquiry Card

New Products

CAN TYPE RELAY

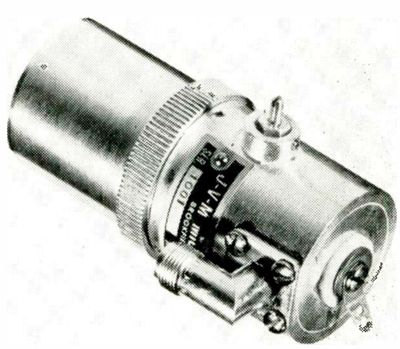
Type FC-215 subminiature hermetically-sealed can type relays are rated for 10 adc. They withstand 30g vibration, and 50g shock; operate at ambients to 125°C and meet MIL-R-575C and MIL-R-25018. Standard operating coils are 26.5 vdc nominal—coil resistance, 400 ohms. Weight is 3 oz. Size is ⅝ x 1-1/32 x 1¼ in. Hook type and long and short wire lead terminals available. Headers have 0.2 in. grid spacing. Struthers-Dunn, Inc., Pitman, N. J.



Circle 227 on Inquiry Card

TRIODE CAVITY LINE

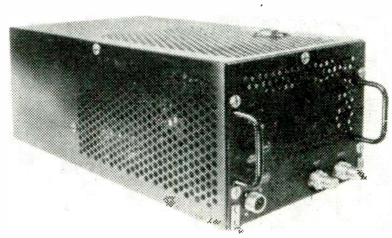
Line of triode cavity components, Mercury '10' series, feature component availability, design selectivity, and uniform performance. Engineered for restricted 10% tuning range, small size, min. weight-frequency stability and temp. compensation are offered. Meet MIL-E-5272 and MIL-E-5400. For a variety of different tube-types, the series is designed for max. power and/or voltage ratings. Designs available from 255 MC to high frequency limits of existing planar triodes. Total of 720 cavities are in the line. J-V-M Microwave Co., 9300 W. 47th St., Brookfield, Ill.



Circle 228 on Inquiry Card

COOLING UNITS

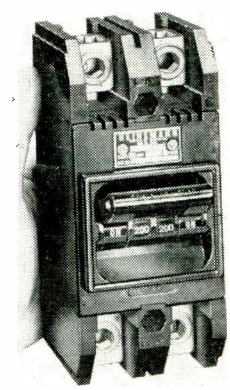
Units are used to cool tubes and high power resistors and can be used as a heat exchanger for calorimeters. They are self-contained and include heat exchanger, circulating pump, storage tank, flow and pressure interlocks. Sizes range from 10 w. to 50,000 w. Fluids used are transformer oil OS45 or DC200 fluid. Can be arranged for 28 volts dc or 110 volts ac power supply. Electro Impulse Laboratory, 208 River Street, Red Bank, N. J.



Circle 229 on Inquiry Card

CIRCUIT BREAKER

The SE33, circuit breaker is a 2-pole breaker in "compartments" linked externally by a single handle to provide effective dielectric separation of breaker contacts. The 200-amp breaker reacts only to load current changes produced in a solenoid sensing coil. Amb. temp. has no effect upon current rating or trip points. Instantaneous tripping at 10 times the breaker rating, or above, provides fast interruption under short circuit conditions. Can be reset without allowing time for elements to cool. Interrupting capacity is 10,000 a. Heinemann Electric Co., 388 Plum St., Trenton, N. J.



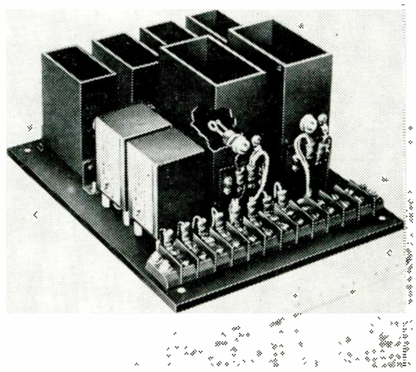
Circle 230 on Inquiry Card

Circle 109 on Inquiry Card

New Products

POWER CONTROL UNITS

Power control units use magnetic gating amplifiers driving silicon controlled rectifiers replace conventional electromechanical equipment such as amplidynes and motor generator sets.

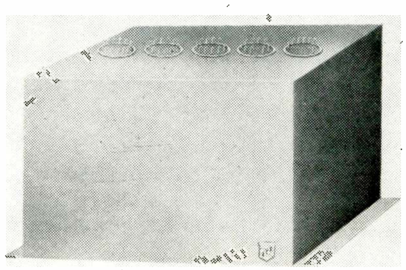


They provide voltage/current regulation, ac servo motor control, dc motor speed and position control, and temperature and light dimming control. Applications are in missiles, aircraft, radar tracking systems, semi-automatic or completely automatic control systems, etc. Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y.

Circle 231 on Inquiry Card

DELAY LINE

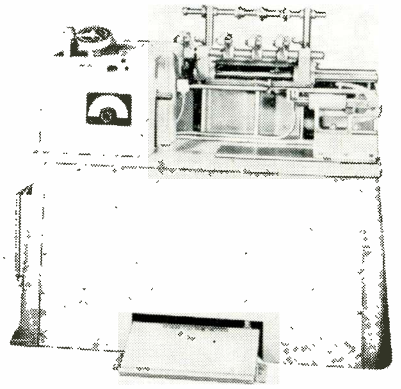
Lumped-Constant Delay Line, Model 61-34, has a delay time/rise time ratio of 170/1. Designed for a special communications application, the Model 61-34 has a delay of 200 μsec with a rise time of 1.16 μsec. Attenuation less than 2 db. Frequency response (3 db) = 325 KC. The unit has 50 taps with an accuracy of ±0.2 μsec at each tap. Dimensions, 6 x 9 x 13½ in. ESC Corporation, 534 Bergen Boulevard, Palisades Park, New Jersey.



Circle 232 on Inquiry Card

COIL WINDER

Multiple transformer/bobbin winder eliminates gear changes and permits instant change-over from one wire gauge to another. Model 500-AM multiple winds power, audio and

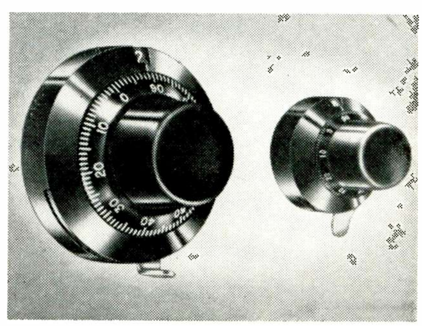


similar types of coils. Dial is calibrated in wire sizes from 10 to 31 A.W.G., for selection of correct winding pitch. Machine also handles wire finer than 31. Max. coil OD is 16 in. Max. winding stroke 9 in. Max. loading distance for multiple winding 24 in. Geo. Stevens Mfg. Co., Inc., Pulaski Rd. at Peterson, Chicago 46, Ill.

Circle 233 on Inquiry Card

INDICATING DIALS

Two 10-turn indicating dials provide error-free readings of potentiometer full turns. Only 1 number appears in the totaling window. The proper turn number clicks in view and stays firm while a precisely calibrated dial registers partial turns in increments of 1/100. Available in 1



in. (Model 10) and 1-13/16 in. (Model 20) sizes to fit 0.250 dia. shafts. For 0.125 shafts, an adapter bushing can be supplied. Spectrol Electronics Corp., 1704 South Del Mar Avenue, San Gabriel, Calif.

Circle 234 on Inquiry Card

New Products

MICROPHONES

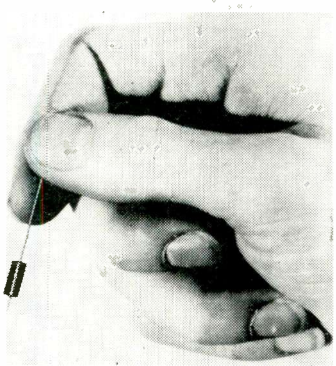
Matched 55S Unidynes are guaranteed to be within 2 decibels of each other across their entire frequency range (50 to 15,000 CPS) for stereophonic recording. The twin dynamic

microphones have multi-impedance switches. Their cardioid pickup pattern makes them effective at 75% greater distance than omni-directional microphones and reduces the pickup of distracting background noise by 73%. Shure Brothers, Inc., 222 Hartrey Ave., Evanston, Ill.

Circle 160 on Inquiry Card

CHOKE COIL

The High Inductance Value Wee-Ductor is a subminiature choke coil with excellent shielding characteristics. It measures 0.160 in. in diameter and 0.375 in. in length, with a full range of inductances from 1.5 mh to 18 mh. Meets MIL-C-15305A.



Sealed in epoxy resin for protection against climatic and mechanical conditions. Electronics Division of Nytronics, Inc., 550 Springfield Avenue, Berkeley Heights, New Jersey.

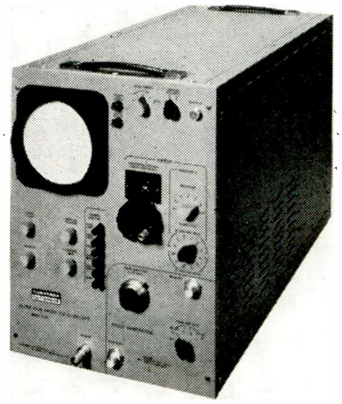
Circle 161 on Inquiry Card

Circle 88 on Inquiry Card

New Products

OSCILLOSCOPE

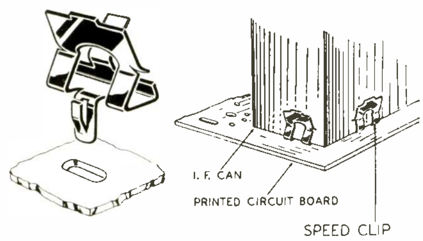
Millimicrosecond oscilloscope, Model 12AB, employing "sampling" technique to achieve a combination of a rise time better than 400 μμsec and a sensitivity of 3 mv/cm with 3:01 signal-to-noise ratio. Samples are taken from the successive, unamplified repetitive pulses under investigation, and their amplitudes are sampled for a very small time interval (400 μμsec), amplified, stretched to about 1 msec. and displayed as a composite picture of the pulse shape on the CRT. Lumatron Electronics, Inc., Westbury, L. I., N. Y.



Circle 235 on Inquiry Card

FASTENER

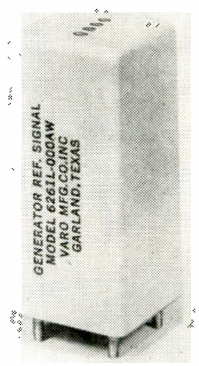
Dual-functioning Speed Clip for fastening aluminum i-f cans to printed phenolic circuit boards. Serving also as a positive ground for i-f cans, it is pushed by hand over the bottom edge of the i-f can, requiring no special cut-outs in the can or special assembly tools. Two barbs on the clip bite into the side of the can, providing firm retention and an excellent grounding connection between can and clip. A spring tab supplies tension until the final soldering operation. Tinnerman Products, Inc., Cleveland, Ohio.



Circle 237 on Inquiry Card

FREQUENCY GENERATOR

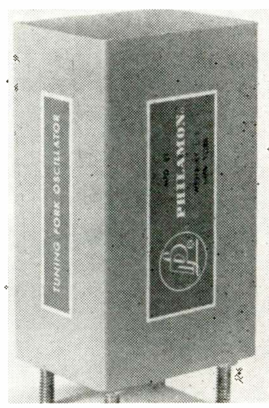
Frequency generator, Model 6261 uses a bimetallic tuning fork to provide precision frequency. The oscillator circuit uses 2N334 and 2N335 silicon transistors, precision wire wound resistors and metallized mylar capacitors for operation to 125°C. It has an output of 2.5 v. with frequencies from 300 to 4000 CPS at accuracies of 0.1% to 0.01%. Fork and oscillator are in a hermetically sealed can. Varo Mfg. Co., Inc., 2201 Walnut St., Garland, Tex.



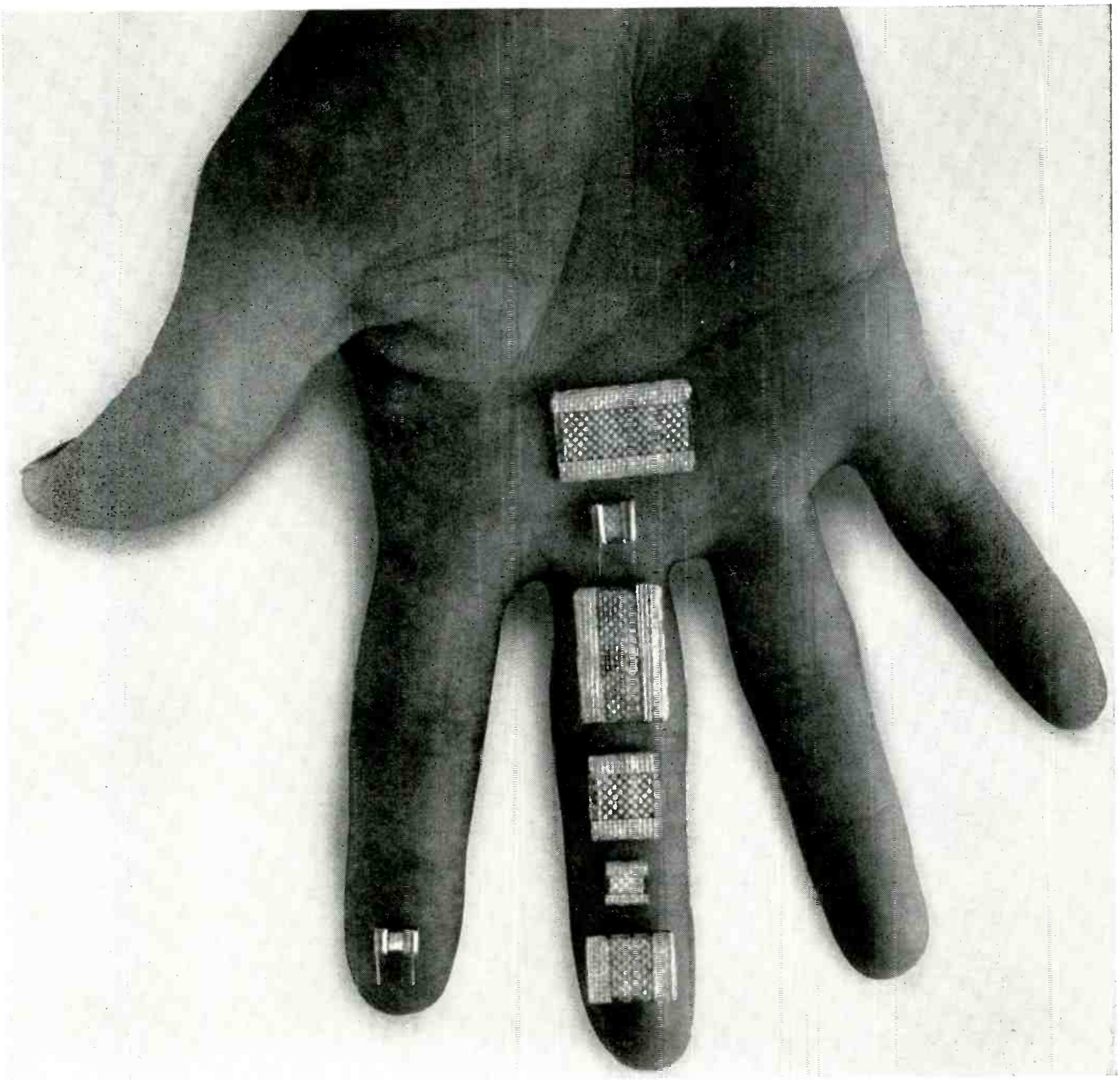
Circle 236 on Inquiry Card

TUNING FORK OSCILLATOR

Model MJXO Frequency Signal Source from 400 to 4000 CPS is available in ±0.05%, ±0.02% and ±0.01% accuracy and stability for continuous operation (−55° to +85°C). Operating from 28 vdc at 20 ma to supply 0.23 RMS min. sine wave into 2K load or 6 v P/P min. clipped sine wave into 7.5K load. Potted in silicone rubber and hermetically sealed. Variations in waveform, output, and input available. Philamon Labs. Inc., 90 Hopper St., Westbury, N. Y.



Circle 238 on Inquiry Card



NEW Corning wafer capacitors run from 1 to 10,000 uuf

Uuf for uuf the smallest, most stable capacitors you can get for printed circuits and high reliability components.

Never has so much capacitance been crammed into so little space with so much ruggedness and reliability.

The smallest gives from 1 to 560 uuf while resting in a space only 0.00204 cubic inch in volume.

The largest runs from 4301 to 10,000 uuf and takes up only 0.02106 cubic inch.

You sacrifice nothing for size. The flat shape gives you more options in mounting, e.g., slot or flat mounting in printed circuits.

When you need leads we can provide those too, in the W-5 and W-4 sizes as WL-5 and WL-4.

These capacitors are rugged and reliable. The dielectric and conductor layers are fused at high temperatures and need no encasement. You'd almost have to smash one completely to stop its operation. Meets or exceeds the performance requirements of MIL-C-11272A.

For complete specs write for a new 4-page bulletin to Corning Glass Works, Dept. 546, Bradford, Pa.

Capacitor	Capacitance (uuf)	Volume (approx.)
W-5	1 to 560	0.00204 in.^{3}
W-4	561 to 1000	0.00327
W-3	1001 to 2700	0.00702
W-2	2701 to 4300	0.01951
W-1	4301 to 10,000	0.02106

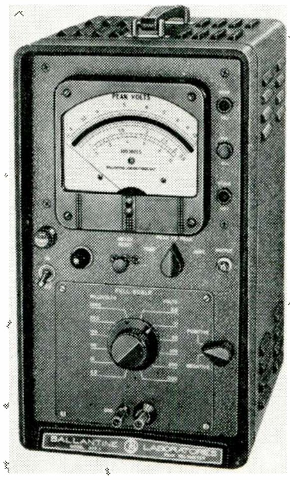
W-5, W-4 also available with leads as WL-5, WL-4

CORNING ELECTRONIC COMPONENTS

New Products

VOLTMETER

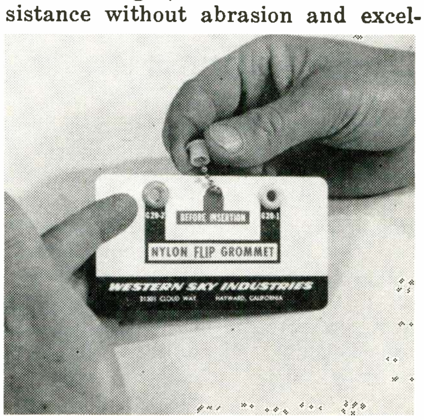
Peak responding Voltmeter, Model 305A measures peak or peak-to-peak values of repetitive waveforms. Operating mode responds to a peak-to-peak and + or − peak. Dc component is not measured. Frequency range is 5 CPS to 500 KC, but distorted waveforms with harmonics up to 2 MC, can be measured. Pulses from 0.5 μsec to 5 msec and a repetition rate from 5 to 500,000 pps can be measured. Accuracy is 2% to 5% depending on waveform. Precision of reading is better than 0.5%. Can be used as a wideband amplifier with a gain of 86 db and a source impedance of approx. 3 ohms in series with 0.22 μf. The max. output voltage from the amplifier is 150 v. pp. Ballantine Labs., Boonton, N. J.



Circle 239 on Inquiry Card

GROMMETS

WSI one-piece solid nylon Flip Grommets features installation with simple tools at room temperature, refusal to shake loose or pop out, unusual strength, remarkable wear resistance without abrasion and excellent insulative qualities. Available in white and color. Shown is a sample card with three grommets. Western Sky Industries, 21301 Cloud Way, Hayward, California.

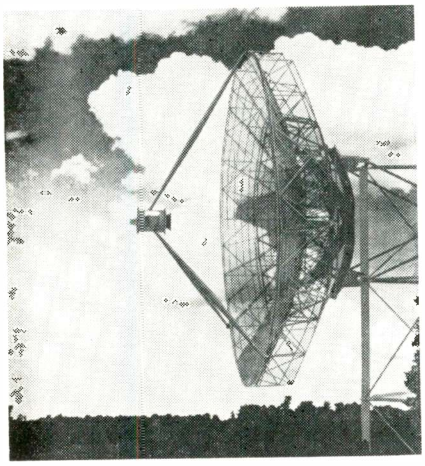


Circle 240 on Inquiry Card

New Products

ANTENNA

Type D-28, Hubloc antenna, is the first of a new series of lightweight, heavy duty, large antenna structures featuring high surface accuracy, high stiffness to weight ratio, simple instal-

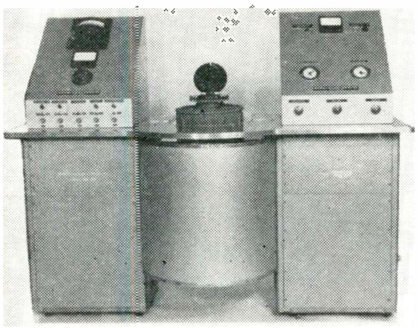


lation procedures, and economy of transportation. Reflector diameter is 28 feet. Focal length is 10.5 feet. Weight is 1,575 pounds. Wind load rating is 30 psf. Plane and bi-polar feeds are available for any frequency band in the range from 400 MC to 2700 MC. Andrew Corporation, 363 East 75th Street, Chicago, Illinois.

Circle 241 on Inquiry Card

VACUUM FURNACE

Vacuum furnace, Model VF-91, has a full line of attachments for handling all possible laboratory jobs. It will perform melting, heating, treating and brazing operations, and will grow single crystals by induction or resistance heating in high vacuum or inert atmospheres. Depending on



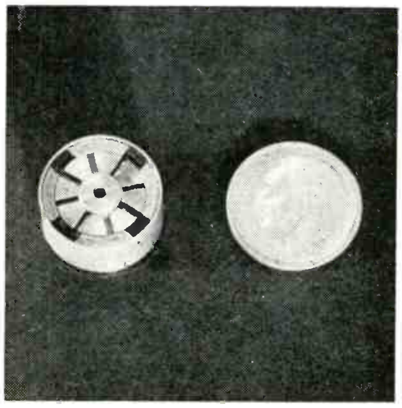
specimen size and convenience, these operations may be performed with the furnace in either vertical or horizontal position. Materials Research Corp., 47 Buena Vista Ave., Yonkers, N. Y.

Circle 242 on Inquiry Card

New Products

SLIP CLUTCH

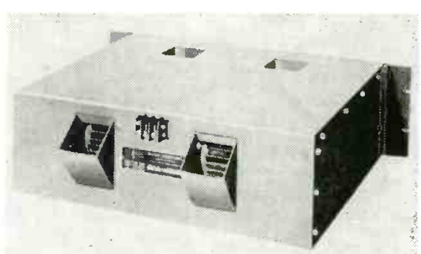
Adjustable slip clutch is available for use in precision gear trains, computers, servo mechanisms, breadboard setups, recorders and other devices requiring precision overload protection. Its qualifications are: Adjustable, torque range 0 to 100 in.-oz.; repeatable breakaway torque; no backlash, chatter, or gaulling; corrosion resistant; small: 0.630 x 0.450 in.; weight: 0.03 lbs.; concentricity: to 0.003 in.; may be supplied with integral gear blank; gear made per order: Special shaft configurations available. Northern Union, Inc., 1020 Holly Ave., Arcadia, Calif.



Circle 243 on Inquiry Card

RACK MOUNTED BLOWER

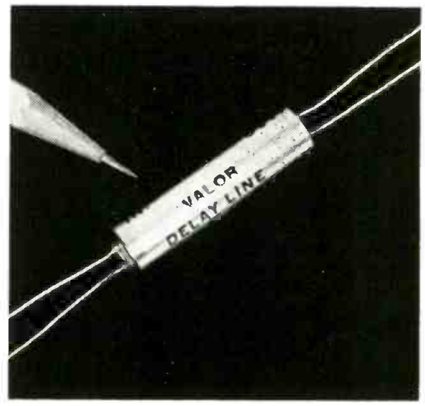
Quadruple exhaust rack mounted blower for electronic cabinet cooling applications, Model 4EB300, produces 250 CFM with a very quiet air delivery. Features vertical and diagonal exhausts. Ventilators available front or rear. Dimensions 19 in. x 5¼ in. The filter is removable from the front without removing the unit from the cabinet. The motor meets CC-M-636A. Grills are stainless steel. McLean Engineering Laboratories, Inc., P. O. Box 228, Princeton, New Jersey.



Circle 244 on Inquiry Card

DELAY LINE

A one μsec delay line with a 0.2 μsec rise time is available in a 0.4 x 1.5 in. metal case. The precision lumped constant unit, 10C5-5/14, is suitable for printed circuit and transistor applications. Specs: characteristic impedance 1400 ohms; attenuation 3%; temp. characteristic $-0.03\%/^\circ C$; temp. range $-55^\circ C$ to $+105^\circ C$; build to MIL specs; molded in hermetically sealed brass tube with leads brought out through glass-to-metal end seals; case finish—fused tin plate. Valor Instruments Inc., 13214 Crenshaw Blvd., Gardena, Calif.

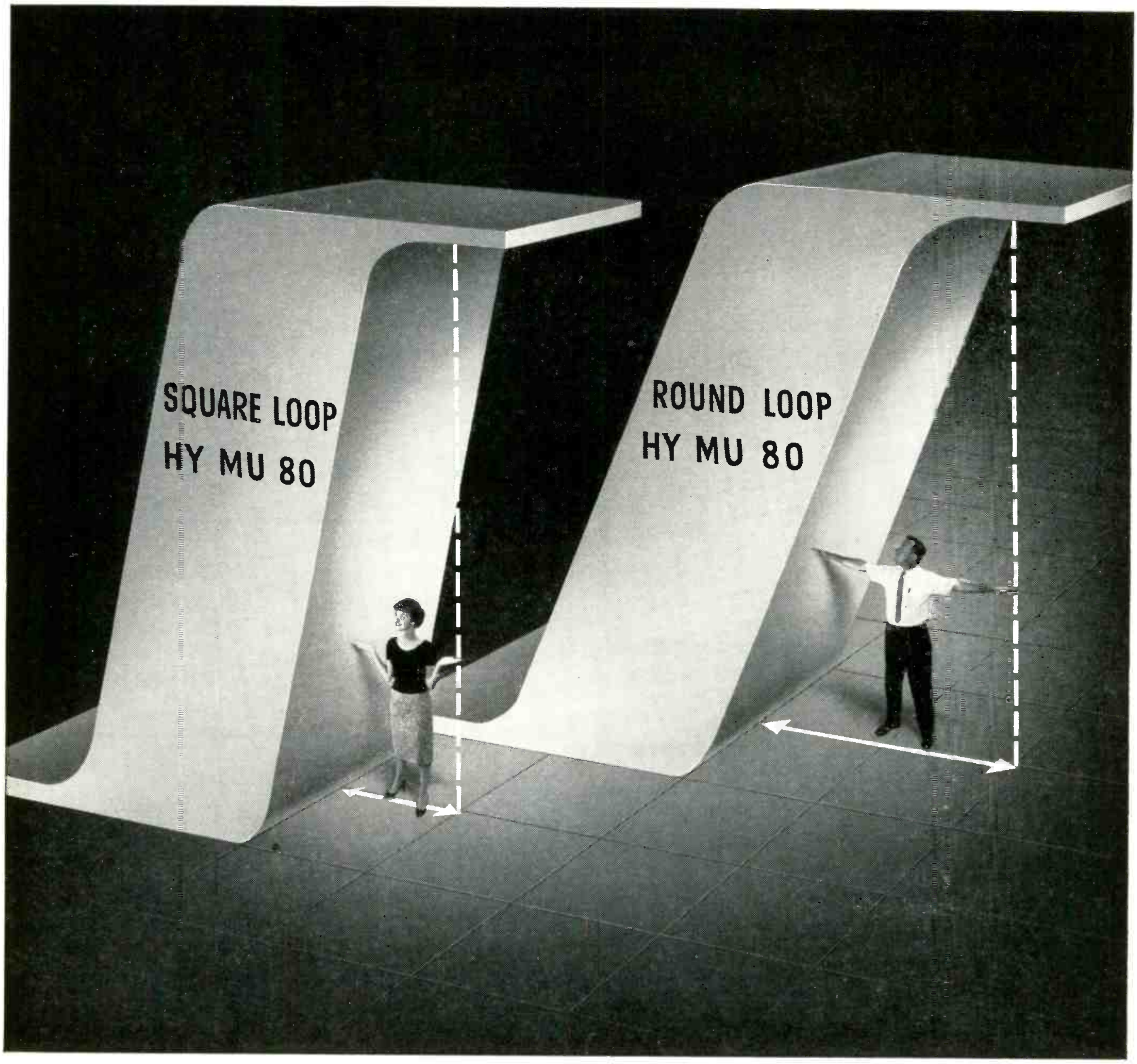


Circle 245 on Inquiry Card

AMPLIFIER

Non-overload linear amplifier built to ORNL Spec. Q-1593-8. Model 851, DD-2, is a wide-band amplifier with excellent characteristics of high resolution and gain as well as fast overload recovery. Recovery time is less than 7 μsec for overload up to 200 times. Recovery time is better than 20 μsec with 1000 times overload. Designed for scintillation spectrometry and proportional counting. Several optional accessories are available. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.

Circle 246 on Inquiry Card



Vive la différence in Hy Mu 80!

For greater sensitivity—Magnetics, Inc. makes Round Hy Mu 80 for more output at low flux densities
For greater gain—Magnetics, Inc. makes Square Hy Mu 80 for more voltage amplification

There's an important difference in the two basic kinds of Hy Mu 80, Round Loop and Square Loop. By taking advantage of it, you design magnetic amplifiers with better performance and efficiency characteristics. We stock standard tape wound cores made of *both*, to be sold at non-premium prices. We want you to order the right kind.

Round Hy Mu 80 is demanded when flux densities are down around the 10 to 50-gauss level. Its high initial permeability results in great sensitivity. It also means fewer windings, thus smaller sizes. Combine higher inductance, great sensitivity and small size, and if you are a designer of devices like low level transformers or thermocouple amplifiers, then you want Round Hy Mu 80 tape cores.

On the other hand, if you design sensitive high gain magnetic amplifiers you need Square Hy Mu 80. The transfer curve is so linear and so nearly vertical that a minute change in input produces an extremely sharp response. When only a small bias supply is available, you get a lot more amplifier per dollar. Preamplifier designers are among our best customers.

So *vive la différence!* Order the right Hy Mu 80 for your needs. We'll supply either, and what's more, we'll supply them quickly. Want the full story? *Write Magnetics, Inc.,* **Dept. EI-71,** *Butler, Pennsylvania.*

MAGNETICS inc.

International

Electronic Sources

Up-to-the-minute abstracts of articles appearing in the leading foreign electronic engineering journals

ANTENNAS, PROPAGATION

Ionospheric Propagation on Long and Medium Waves: Review of the Work of the European Broadcasting Union, Von W. Ebert, H. Ehlers, R. Dobiasch. "Rundfunk." #5, Oct. 1959. 14 pp. Since October, 1952, extensive series of measurements concerning the ionospheric propagation of long and medium waves have been carried out within the organization of the European Broadcasting Union (EPU). The aim of these measurements is to obtain well founded basic information for establishing a generally recognized nocturnal propagation curve or of a family of such curves. The article reviews the present state of the work. It briefly describes the measuring and evaluation methods. It indicates the degree of accuracy to be expected. (Germany.)

The Design Criteria of a Common Aerial System for Simultaneous Transmission and Reception of V.H.F. Signals, J. K. Grierson. "El. Eng." Sept. 1959. 4 pp. A common aerial system that consists of five sections is described. The sections are a transmitter, a transmission coupling network, a receiver, a reception coupling network and an aerial. The transmission and reception coupling networks enable a single aerial to be used for transmission and reception of frequency-spaces signals without the necessity of time sharing. The coupling networks are considered in detail and practical values of components are assigned. (England.)

AUDIO

New 100-W Loudspeaker Amplifier Type, V 214, W. Kellermann. "El. Rund." Oct. 1959. 5 pp. Large studios often require 100-w amplifiers to reproduce recorded information in the original volume. The 100-w Hi-Fi Amplifier Type V 214 is a new one in the series of studio amplifiers as V 69a, V 72, V 76, etc. and is here described with particular stress on main problems like output transformer and power supply. Adjustable controls and a monitoring instrument allow for accurate alignment of the amplifier to even very low distortion and for supervision of correct performance during operation. (Germany.)

Modern Acoustical Engineering, I. General Principles, D. Kleis. "Phil. Tech." Vol. 20, #11, 1959. 18 pp. It is now possible with electrical techniques to control the acoustics of an auditorium so as to provide the most favorable acoustic conditions for widely diverse performances (stage plays, opera, concerts). For example, the intelligibility of speech in a hall having a long reverberation time can be improved by reinforcing the direct sound and beaming it towards the audience. (Netherlands, in English.)

CIRCUITS

Investigation of Three-Phase Load Self-Saturated Magnetic Amplifier, A. L. Pisarev. "Avto. i Tel." Sept. 1959. 15 pp. Steady-state operation of the three-phase load, self-saturated, magnetic amplifier for amplifiers with free and suppressed current variable component in control windings is considered. Methods of plotting control characteristics are proposed and the problem of the rectifier voltage is analyzed for both cases. (U.S.S.R.)

Minimization of Boolean Functions that Characterize Switching Circuits, M. A. Gavrilov. "Avto. i Tel." Sept. 1959. 22 pp. There is considered the method of minimization of Boolean functions that characterize the switching circuits. The method is based on the analysis of realizability of conditions of the switching circuit operation. (U.S.S.R.)

Influence of Balancing Circuit Interconnection on Dynamic Properties of AC Bridges and Potentiometers, V. Yu. Kneller. "Avto. i Tel." Sept. 1959. 12 pp. There is analyzed dependence of the critical gains of the balancing circuits of the automatic ac bridges and potentiometers on the circuit interconnection. (U.S.S.R.)

A Special Effect Found in Several Pulse Systems, J. Tschauner. "Nach. Z." Sept. 1959. 3 pp. Many properties of closed circuit pulse systems differ from the properties of closed circuit analogue steady state systems. The transmission functions in general have the same order z=exp pr as the transmission functions of analogue steady state systems as far as p is concerned. Consequently, the intermittent effect of the controlling quantity will not change the order of the system. However, systems are known, which, when pulse operated will increase the order by one degree in comparison to the conditions for steady state operation. (Germany.)

Operation of Transistor Blocking Oscillators and Synopsis of Their Basic Circuits, W. Hilberg. "El. Rund." Sept. 1959. 6 pp. The discussion starts from the mode of operation of a transistor blocking oscillator in a special circuit. From this, formulas for pulse duration and building-up time can be derived with the aid of approximated equivalent circuits. Effects of transistor parameters, transmission ratios, stray inductances and capacitances are investigated and simple rules for dimensioning are obtained. This is followed by a compilation of basic circuits of monostable blocking oscillators with special regard to their application. In conclusion, a compilation of the simplest astable blocking oscillators is given. (Germany.)

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
E. & R. Eng. Electronic & Radio Engineer
El. Energy. Electrical Energy
GEC J. General Electric 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

Ann. de Radio. Annales de Radioelectricite
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
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 Ubertragung
El Rund. Electronische Rundschau
Freq. Frequenz
Hochfreq. Hochfrequenz-technik und Electroakustik
NTF. Nachrichtentechnische Fachberichte
Nach. Z. Nachrichtentechnische Zeitschrift
Rundfunk. Rundfunktechnische Mitteilungen
Vak. Tech. Vakuum-Technik

POLAND

Arch. Auto. i Tel. Archiwum Automatyki i Telemechaniki
Prace ITR. Prace Instytutu Tele-I Radiotechnicznego
Roz. Elek. Rozprawy Electrotechniczne

USSR

Avto. i Tel Avtomatika i Telemakhanika
Radio. Radio
Radiotek. Radiotekhnika
Rad. i Elek. Radiotekhnika i Elektranika
Iz. Acad. Bulletin of Academy of Sciences USSR.

- Photocopies of all foreign articles are available at 75 cents per page, remitted with order. Unless otherwise indicated, articles appear in language native to country of origin.
- A reprint of this section. "International Electronic Sources" is available without charge.

Requests for the above should be sent, on company letterhead, to:

Electronic Sources Editor
ELECTRONIC INDUSTRIES
Chestnut & 56th Sts.
Philadelphia 39, Pa.

International ELECTRONIC SOURCES

A Circuit for Electric Integration and Differentiation of Periodic Functions, W. Berger, F. Hovelmann, and H. J. Kossler. "El. Rund." Sept. 1959. 3 pp. A circuit is shown with the help of which periodic functions can be integrated or differentiated. The integration or differentiation is carried through in two steps independent of each other with RC or RL members separated by a valve. The conditions for the integration or the differentiation of a given magnitude may be realized easily. The error made in the integration can be neglected within a measuring precision of 1%, the differential is errorless. The output magnitude is increased by the amplification of the valve in the circuit compared with the simple RC or RL member. The amplification has no influence on the error of the output. (Germany.)

Concertina Phase-Splitter—2, Low Frequencies. "E. & R. Eng." Aug. 1959. 3 pp. (England.)

Signal Flow Graphs Application to Linear Circuit Analysis, R. F. Hoskins. "E. & R. Eng." Aug. 1959. 7 pp. This paper is an account of the signal flow graph technique of circuit analysis developed by S. J. Mason in two "Proc. I.R.E." papers. This technique can be applied with advantage to transistor-amplifier circuits, and the treatment in this article enables the results to be directly related to Bode's classical feedback theory. Detailed accounts are given of the formal operations necessary to reduce flow graphs to simpler forms, to which Mason's gain formula can be easily applied. (England.)

Switching Circuits Using Bi-Directional Non-Linear Impedances, T. B. Tomlinson. "J. Bire." Sept. 1959. 21 pp. In a brief general review of logic circuitry, a case is developed for a bi-directional, non-linear switching element. In order to compare circuits using such elements with those using standard semiconductor diodes, the main features of diode gates are considered in detail. Particular attention is paid to design of p-n-p transistor driver stages and their dependence on the logic sequence. Circuits using a bi-directional "Constant voltage" element are described, including a "two-decision" and gate. Possible types of constant voltage element are discussed and experimental results are given for multi-electrode silicon carbide devices. An interesting feature of the latter is the non-linear behavior of capacitance. An attempt is made to compare gating circuits employing constant voltage, bi-directional elements with standard diode gates from a performance/cost point of view. (England.)

Transistors and Saturable-Core Transformers as Square Wave Oscillators, G. C. Fleming. "El. Eng." Sept. 1959. 3 pp. The use of transistors as switches for the dc supply to saturable core transformers is described and it is shown that by this means, small and efficient convertors and invertors can be constructed. The common base, common emitter and common collector configurations are considered and methods of obtaining a multiphase output are described. (England.)

Transistor Amplifiers for Sound Broadcasting. "BBC Mono" #26. Aug. 1959. 15 pp. This monograph is concerned with the application of transistors to the audio-frequency amplifiers employed in sound broadcasting, for which a high standard of performance is required. The principles followed in the design of such amplifiers are discussed and five examples of various types are described, with performance details. The operating conditions of dc feedbacks pairs and of super-alpha pairs are analyzed and some numerical evaluations are given. Finally some conclusions are drawn regarding the use of transistors in high performance amplifiers of this nature. (England.)

COMMUNICATIONS

The Stereo Directional Mixer—A New Unit for the Studio, K. Bertram. "El. Rund." Oct. 1959. 5 pp. Viewpoints are discussed which have led to the conception of a novel stereo mixing technique. The heart of this conception is the stereo directional mixer of which the design and mode of operation are described in detail. The new technique is explained by an example involving 5 stereo channels. In conclusion, the advantages of this method are summarized. (Germany.)

New U.H.F. Air-to-Ground Communications for the British Armed Forces, J. G. Cottrell. "Brit. C.&E." Aug./Sept. 1959. 6 pp. This is the first of two important articles in which new equipment for u.h.f. voice communications in the British Armed Services is described. This article briefly reviews the reasons for adopting u.h.f. and the events leading up to the production of the equipments concerned. The range of fixed ground equipments is described and the techniques employed are discussed. The second article will cover the airborne transceiver including the test gear developed for servicing this sub-miniature equipment. (England.)

New U.H.F. Air-to-Ground Communications for the British Armed Forces, Part 2, D. C. Dalton. "Brit. C.&E." Oct. 1959. 6 pp. This article describes the new equipment installed in aircraft, which forms the primary voice communication link with the ground. The design is entirely new and revolutionary in concept in order to provide the required facilities within a very small space and with low weight. In view of the wide use of subminiature techniques and the resulting high component density, accessibility problems tend to be aggravated, and preparations for servicing in the field must be correspondingly thorough. Test equipment which has been specially developed to ensure easy and rapid repair is described. The article ends by touching on some future developments. (England.)

COMPONENTS

The Synchronized DC Motor, H. Volz. "El. Rund." Sept. 1959. 3 pp. A new motor has been developed from the rotary converter. The dc branch supplies the main torque while the ac branch is loaded only with torque and voltage variations. The motor thus runs constantly at a speed controlled by ac frequency. Pull-in phenomena and pull-in range are defined and computed. (Germany.)

A Method of Reducing the Time Lag of Transducers Which Have an Exponential Response, L. Whitlow and M. J. Porter. "El. Eng." Sept. 1959. 7 pp. A method of reducing the time lag of thermocouples, or other transducers which have a simple exponential response, is described. The output voltage from a thermocouple is added to its amplified derivative, this corrects the response for both phase and amplitude. The limiting factor, in reducing the time lag, is the ratio of the input signal to the electrical noise generated in the equipment. Design details and the performance of a drift corrected dc amplifier and a highly stable power supply are also given. (England.)

COMPUTERS

Universal Input Stage for Electronic Counters, H. Mahnau. "El. Rund." Sept. 1959. 4 pp. The applicability of electronic pulse counters depends largely on the properties of the pulse-input stage (apart from the counter ratings). The stage here described permits one to match counters to various measuring problems, to integrally limit the pulse amplitude, and to adjust defined times of resolution. By combining several input stages, single and multiple coincidences and anticoincidences may be selected. Two anticoincidence-circuit stages in conjunction with discriminators can be operated as a single-channel pulse-amplitude analyzer. (Germany.)

The Fortran System, W. Heineken. "El. Rund." Sept. 1959. 4 pp. More and more engineers are employing electronic computers for their calculations. A precondition for this cooperation between man and machine is the availability of means for preparatory work. One of such means is the Fortran system. It is outstading for its adaptation to mathematical symbols and can be learned easily. Based on simple examples and a review of the Fortran system structure, the application and the advantages of this system are explained. (Germany.)

Millimicrosecond Digital Computer Logic, Prof. N. F. Moody and R. C. Harrison. "El. Eng." Sept. 1959. 4 pp. A system of fast pulse logic is described which combines the efficiency of transformer coupled stages with digit delay tolerances approaching that of dc coupled systems. Logical circuits for OR, AND, INVERTOR and RECLOCK are shown, together with a driver which permits a "fan out" factor of 5. Transistor circuits are used throughout. (England.)

CONTROLS

Noise Influence on Operation of Frequency Phase Adjustment Circuit, V. I. Tikhonov. "Auto. i Tel." Sept. 1959. 9 pp. Effect of external normal noises and circuit fluctuations on the inertialess circuit of frequency phase adjustment are analyzed with the help of Fokker-Plank equations. Formulae for mean value and variance of the synchronized generator frequency are obtained. There is ascertained that the problem considered in the paper is similar to the synchronization problem of the automatic generator with noises. (U.S.S.R.)

Experimental Determination of Transfer Function of Automatic Control System Blocks with the Help of Electronic Analogues, L. N. Darovskikh. "Auto. i Tel." Sept. 1959. 8 pp. There is proposed the method of determination of transfer function coefficients of a circuit unit of the automatic control system. The main point of the method is the transformation of the transfer function by means of designing a circuit including electronic analog computers. The said transformation makes it possible to get a system of equations to determine unknown coefficients of the transfer function. Experimental data are estimated with the help of the checking equation. Use of the method in special cases is illustrated with examples. (U.S.S.R.)

Calculation of Nonstationary Operation In Linear Systems with Reducing Order of Differential Equation, A. V. Kaljaev. "Auto. i Tel." Sept. 1959. 9 pp. There is considered calculation of transient processes in linear systems with constant parameters by means of reducing the order of differential equation. Use of the method is illustrated with examples. (U.S.S.R.)

for voltage stabilizing... rectifying...controlling...

THERE'S A RAYTHEON GAS DIODE TO MATCH YOUR TOUGHEST POWER-SUPPLY 'SPEC'

typical characteristics

VOLTAGE REGULATOR TUBES

Type	Base	D.C. Operating Voltage	Current Range	Regulation
OA2WA CK6626/OA2WA CK6073, OA2	Miniature	150 v.	5 — 30 ma.	2 v.
OB2WA CK6627/OB2WA CK6074, OB2	Miniature	108 v.	5 — 30 ma.	1 v.
OC2	Miniature	75 v.	5 — 30 ma.	3 v.
CK5787	Subminiature	98 v.	5 — 25 ma.	3 v.
CK5787WA	Subminiature	98 v.	5 — 25 ma.	1.5 v.
CK6542	Subminiature	148 v.	5 — 25 ma.	2 v.
	Corona Voltage Regulators			
CK1038	Subminiature	885 — 915 v.	5 — 55 μa.	15 v. max.
CK5962	Miniature	700 v.	2 — 55 μa.	15 v. max.
CK6437	Subminiature	700 v.	5 — 125 μa.	15 v. max.
CK6438	Subminiature	1200 v.	5 — 125 μa.	20 v. max.

Circle 122 on Reader Service Card

VOLTAGE REFERENCE TUBES

Type	Base	D.C. Operating Voltage	Current Range	Regulation	Voltage Jump Max.
CK5651	Miniature	85 v.	1.5 — 3.5 ma.	1.5 v.	0.1 v.
CK5651WA	Miniature	85 v.	1.5 — 3.5 ma.	1.5 v.	0.005 v.
CK5783	Subminiature	85 v.	1.5 — 3.5 ma.	3.0 v.	0.1 v.
CK5783WA	Subminiature	85 v.	1.5 — 3.5 ma.	2.4 v.	0.005 v.
CK6213	Subminiature	130 v.	1.0 — 2.5 ma.	1.0 v.	—

Circle 123 on Reader Service Card

COLD CATHODE RECTIFIER TUBES

Type	Construction	Base	Max. Peak Inverse Voltage	Peak Plate Current	Max. D.C. Output Current
OZ4A/1003	Double Diode	Octal	880 v.	330 ma.	110 ma.
CK1005	Double Diode	Octal	450 v.	210 ma.	70 ma.
CK1006	Double Diode	4-Pin.	1600 v.	600 ma.	200 ma.
CK1007	Double Diode	Octal	1200 v.	510 ma.	85 ma.
CK5517	Diode	Miniature	2800 v.	100 ma.	12 ma.
CK6174	Diode	Miniature	2800 v.	30 ma.	3 ma.
CK6659	Diode	Subminiature	2800 v.	40 ma.	8 ma.
CK6763	Diode	Miniature	2800 v.	100 ma.	12 ma.

Circle 124 on Reader Service Card

Detailed technical data bulletins on any of the above types are yours for the asking. Better yet, ask to have a Raytheon sales engineer drop in for a firsthand appraisal of your application and prototype needs — no obligation, of course. Write directly to Dept. 2528.

Small order and prototype quantities available directly from your local Raytheon electronics parts distributors.

Want to Receive Our Technical Data Regularly? We'll be happy to keep you informed of latest technical developments, new products, design tips, etc. An application for addition to our new Technical Information Mailing List is yours for the asking. Write on your company letterhead directly to: W. J. Davis, Dept. 2528, at division address listed.

RAYTHEON

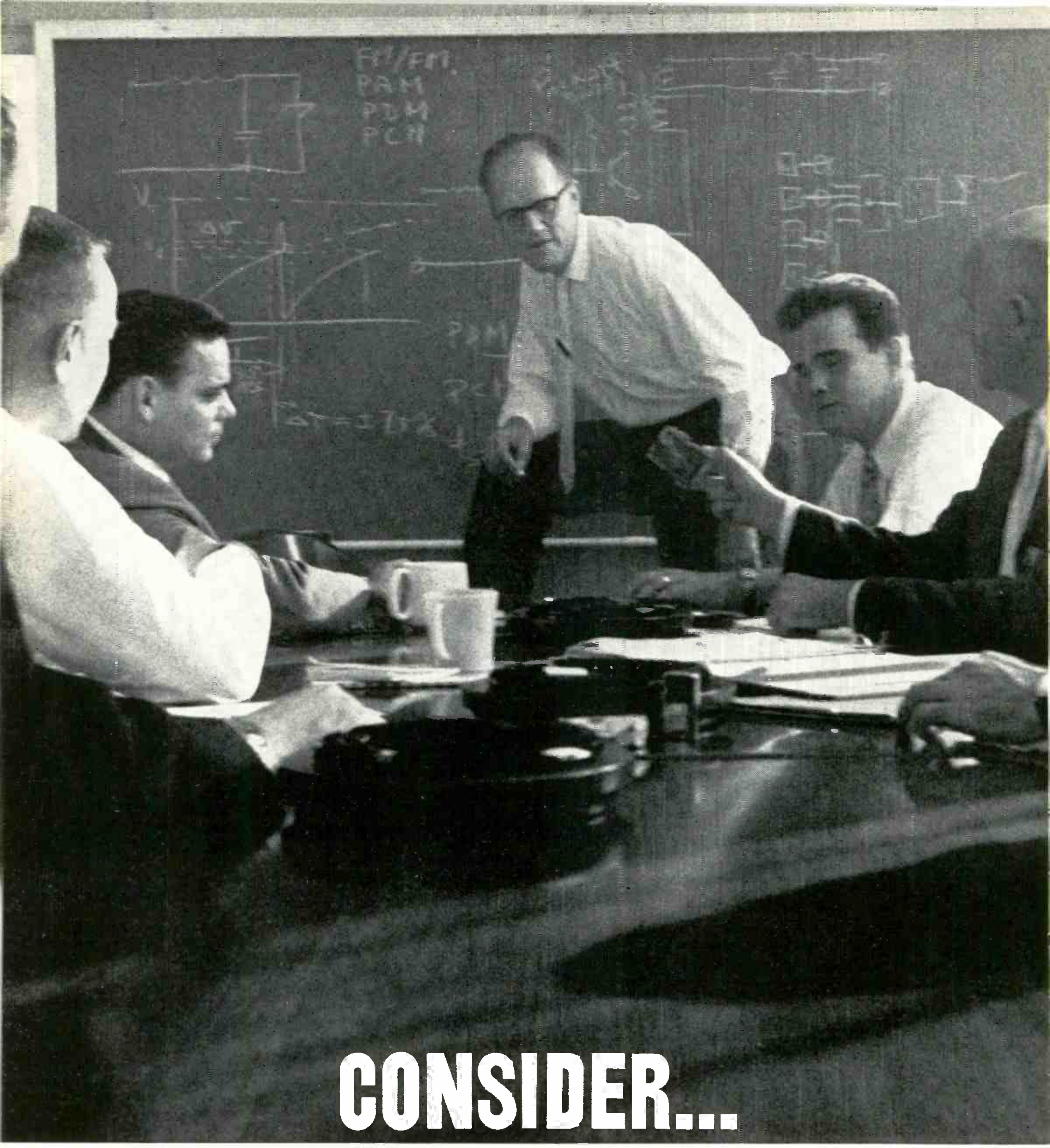
Industrial Tube Subdivision

INDUSTRIAL COMPONENTS DIVISION

57 Chapel Street, Newton 58, Massachusetts

RELIABLE MINIATURE AND SUBMINIATURE TUBES • HARD-GLASS POWER TUBES • GAS TUBES • CATHODE RAY TUBES • STORAGE TUBES

LOS ANGELES, NOrmandy 5-4221 • **SAN FRANCISCO,** Fireside 1-7711 • **CHICAGO,** NAtional 5-4000 • **KANSAS CITY,** Plaza 3-5330
CLEVELAND, WInton 1-7716 • **BALTIMORE,** SOuthfield 1-1237 • **ORLANDO, FLA.,** GArden 3-1553 • **NEW YORK,** PLaza 3-3900 • **BOSTON,** BIgelow 4-7500
GOVERNMENT SALES: BOSTON, BIgelow 4-7500 • **WASHINGTON, D. C.,** MEtropolitan 8-5205 • **DAYTON,** BAldwin 3-8128



Lockheed for telemetry

Out of Lockheed creative engineering sessions such as this come advanced design and proven performance in the field of telemetry. Lockheed's pioneer work on the X-17 project resulted in the first successful telemetering of vital data during re-entry. Research continues to provide even greater reliability of performance to meet present requirements.

The Lockheed Electronics and Avionics Division (LEAD) is currently conducting research in Frequency Modulated and Pulse Modulated Systems for industrial and military needs.

For proven reliability in telemetry components and systems, consider LEAD.

Look to Lockheed for LEADership in Electronics

LOCKHEED ELECTRONICS & AVIONICS DIVISION

Circle 125 on Inquiry Card

REQUIREMENTS EXIST FOR STAFF AND SUPERVISORY ENGINEERS

6201 E. Randolph St., Los Angeles 22

Concerning Calculation of Corrective Networks of Automatic Control Systems After the Criterion of Minimum of Mean-Square Error, V. I. Kukhtenko. "Auto. i Tel." Sept. 1959. 8 pp. There is proposed the method of determining the optimum (from the viewpoint of the minimum of the mean-square error) transfer function when the order of its numerator is lower than the order of the denominator. The connection between the considered problem and the problem of physical realizability of the corrective networks is observed. (U.S.S.R.)

On Analysis of Periodic Process Stability of Non-Linear Control System with Many Degrees of Freedom, V. A. Taft. "Auto. i Tel." Sept. 1959. 8 pp. On the basis of generalization of Hill's equation corollary the corollary of characteristic equation (in final form) of the system with many degrees of freedom is given, the parameters of which are periodic time functions. The result obtained enables usage of Mikhailof's criterium known for the stability analysis of the periodic regime. (U.S.S.R.)

On Frequency Elements of Remote Control, I. N. Lisitskaja, V. N. Michaelovsky, K. D. Nadtochii, V. N. Okhotskaja. "Auto. i tel." Sept. 1959. 6 pp. Frequency relays of various types are considered. Characteristic data of the relays and the generator are given. (U.S.S.R.)

An Electrical Analogue for Dead Time, G. Heller. "rt." Aug. 1959. 4 pp. The performance of a control loop is often greatly affected by elements having dead time. Consequently, analogue computers for investigating control loops must be equipped for the inclusion of dead time elements. This article surveys briefly the various methods of simulating dead time and describes a device developed for this purpose. (Netherlands, in English.)

The Optimum Setup for Control Systems with Dead Time, H. Schliessmann. "rt." Aug. 1959. 9 pp. The transient response of the deviation resulting from a step disturbance of the output of a controlled plant has been calculated for several types of control loop containing dead time, by the use of exponential series of the Laplace transform. The results have been used to determine the settling time corresponding to the prescribed tolerance limits. A thorough investigation of the general integral control system leads to the conclusion that the ideal integral system does not represent the optimum system for a control loop with dead time. (Germany.)

Miniature Servo Components—Part I, M. Lowenberg. "Brit. C.&E." Aug./Sept. 1959. 5 pp. This article discusses the use of miniature servo components in automatic control systems, and outlines the performance characteristics of ac, dc control, dc shunt and permanent magnet motors. A second part of this article will survey the principal characteristics of ac techogenerators, synchros, servo amplifiers, relay controls and will discuss the requirements for gearing, and overall system design. (England.)

Miniature Servo Components, Part 2, M. Lowenberg. "Brit. C.&E." Oct. 1959. 6 pp. This part of the survey deals with the performance characteristics of ac tachogenerators, synchros, servo amplifiers, relay controls, and discusses some of the problems associated with gearing systems, construction and testing. (England.)

Control System for a Pilotless Target Aircraft, E. H. Hall. "Brit. C.&E." Aug./Sept. 1959. 4 pp. A brief account is given of the system used to control one of Britain's pilotless jet aircraft which is used as a target for guided weapon trials. (England.)

A Digital Remote Position Control, K. G. Hilton. "El. Eng." Sept. 1959. 8 pp. This article describes an investigation into the problems involved in constructing a digital remote position control. Shaft position is measured digitally and the servomotor control circuits operate digitally. The article concerns itself with the logical arrangements of the circuits and methods of stabilizing a digital remote position control are discussed. A course system is described which is accurate only to 45° since this was considered to be sufficient to show the principles of the system and the problems involved in designing it. (England.)

GENERAL

Application of Statistical Methods to Determine System Characteristics, Yu. P. Leonov, L. N. Lipatov. "Auto. i Tel." Sept. 1959. 13 pp. There are considered various statistical methods used to determine the characteristics of the linear systems. (U.S.S.R.)

An Apparatus for Cinefluorography with an 11-inch X-Ray Image Intensifier, J. J. C. Hardenberg. "Phil. Tech." Vol. 20, #11, 1959. 15 pp. The article describes a cinefluorographic apparatus for examining large organs such as the heart and lungs. The large image intensifier developed for this purpose (viewing-screen diameter 11 in.) has a reduction factor of 4.5 and gives a luminance intensification of about 100X. The cinefluorographic apparatus proper comprises a 35 mm mirror camera, having an effective aperture ratio of 1:0.83, a dual viewing system for observing the film during cinematography, and a luminance meter capable of automatically keeping the density of the film constant. (Netherlands, in English.)

A Method for the Numerical Calculation of the Original Functions from the Given Component Describing Functions, R. Hofmann. "rt" Aug. 1959. 3 pp. A method is shown which enables the original function of a component describing function to be expressed in the form of a series, thus eliminating the laborious determination of the roots of the denominator polynomial. An example illustrates how well the derived series converges. (Germany.)

Experience on Ultra-high Vacuum in the Devices used for Research on Controlled Fusion, Z. Sledziewski and A. Torossian. "Vide" #81, 1959. 6 pp. Owing to the hard conditions which are to be satisfied by the chambers in the research on controlled fusion and also to the necessity of working with a gas of a high degree of purity despite a very low pressure (some experiments are done in the range from 10^{-3} to 10^{-4} mmHg) vacuum technique is very important in that field. The methods used in 1956 at the beginning of the experiments in this laboratory were progressively improved and we propose to describe here the characteristics of one of the last chambers constructed as they can be of some interest for vacuum engineers. (France, in English.)

Evapor-ion Pump with Liquid Helium Refrigerated Trap, D. A. Degras. "Vide" #81, 1959. 13 pp. (France, in English.)

Power in an Angle-Modulated Wave, W. C. Vaughan. "E. & R. Eng." Aug. 1959. 3 pp. (England.)

The Human Aspect of Engineering Progress, Vladimir K. Zworykin. "J. Bire." Sept. 1959. 16 pp. (England.)

A Transistor Stimulator for Physiological Use, R. E. George. "El. Eng." Sept. 1959. 4 pp. A stimulator is described for measurement of the refractory period which follows excitation in a nerve. It produces pairs of rectangular pulses separated by an adjustable time interval. The duration of both pulses can be varied independently. The maximum amplitude available is 20 v from an impedance not exceeding 2k ohms. The pulse durations are variable in steps from 30 microsec to 30 millisec. The sequence repetition rate may be varied from once in 3 sec to 330 times/sec. (England.)

U. S. 'War Plan' is already on Tape, Andrew Everard. "Brit. C.&E." Aug./Sept. 1959. 2 pp. (England.)

The Medical Electronics Conference in Paris, R. Woolnough. "Brit. C.&E." Oct. 1959. 5 pp. (England.)

Vectors and Trigonometrical Tricks. "E. & R. Eng." Aug. 1959. 3 pp. (England.)

Hybrid Junctions Frequency Characteristics as Phase Dividers and Duplexers, R. Levy. "E. & R. Eng." Aug. 1959. 5 pp. A review of the existing theoretical analysis of hybrid junctions is presented to show how the phase difference between the waves from the two output arms varies with frequency. It is shown that this variation is very small in the case of all well-matched 90° hybrid junctions but, for the hybrid ring, a large variation in phase difference occurs due to asymmetry of the junction. In the application of 90° hybrids to the design of balanced duplexers in the transmit condition, short-circuits are placed symmetrically in two arms (the previous 'output arms') to divert all the power into the fourth arm, and the symmetry of this arrangement gives an inherently broad-band duplexing performance. (England.)

INDUSTRIAL ELECTRONICS

Analysis of Roer Multivibrator Operation in Industrial Telemetering Systems, A. M. Pshenichnikov. "Auto. i Tel." Sept. 1959. 12 pp. Conditions of appearance of multibrator generation are considered with multibrator frequency characterized with magnetization time of the core. There are determined dependence of the output frequency and voltage and the consumed power on the input voltage, on the circuit parameters and on the characteristics of the core material and of the transistors. (U.S.S.R.)

Microwave Generator for Dielectric Heating and Drying of Non-metallic Foils, W. Schmidt. "El. Rund." Oct. 1959. 3 pp. When non-metallic foil and film webs are dielectrically heated by microwaves, the r-f energy has to repeatedly pass through the web for high efficiency. The lines of force of the electric field should be positioned into the plane of the web, and the energy transferred should be concentrated on the web plane. A meandering waveguide arrangement with entrance and exit slots in the waveguide walls facing each other, meets these requirements in spite of the exponential decrease of the energy along the waveguides, thus permitting uniform heating and drying of webs of dielectric material. (Germany.)

A New Design of Mechanical Vacuum Pump, A. Lorenz. "Vide" #81, 1959. 7 pp. The most commonly used vacuum pumps are rotary piston vacuum pumps. They are available in many sizes and different designs. For large capacities, pumps of the rotary plunger type are generally preferred, because they are robust and have several outstanding advantages. Unlike vane pumps, they have no free moving parts like spring loaded blades. So, they cannot stick off and it has been found that rotary piston vacuum pumps run even when they are polluted. (France, in English.)

Reference Sources for Industrial Potenitometric Instruments, G. B. Marston. "Brit. C.&E." Oct. 1959. 3 pp. The accuracy of a potentiometric instrument depends to a large extent on the reference with which the measured voltage is compared. Zener diodes provide a useful alternative to the standard cell, and have important advantages under industrial conditions. (England.)

MEASURE & TESTING

Possibility of Increasing Noise Stability Using Priori Distribution of Parameter Probabilities, V. A. Kashirin, G. A. Shastove. "Auto. i Tel." Sept. 1959. 11 pp. Noise stability of the ideal receiver is considered with taking into account the first law of distribution of priori probabilities of the parameter values. Noise stability is analyzed when nonlinear transformation of the parameter takes place before modulation. There are found the law of the optimum nonlinear transformation of the parameter before its transmission and, as a result of it, increase of the noise stability. Mean-square optimum criterion and information optimum criterion are used. (U.S.S.R.)

Voltmeter for Non-recurrent Voltage Peaks, K. F. Heine. "El. Rund." Oct. 1959. 2 pp. The conventional method of measuring short-lived single events in the laboratory is to use oscilloscopes with long-persistence screens or photographic recording of the screen picture. This costly method must necessarily be confined to laboratories. The auther describes a peak voltmeter for non-recurring events comprising several series-connected rectifiers having increasing time constants from stage to stage. Thus, the voltage across the final capacitor decreases slowly enough to permit its indication by a meter. The number of stages required for this operation are determined, the inherent error is defined, and formulas for the dimensioning are given. A model version of this principle is shown to be an instrument indicating pulse voltages (firing pulses in thyratrons) 1 to 10 kv provided their minimum duratien is 2 to 3 μs. (Germany.)

Admittance Measurements in the Transient Time Range of a Plan-parallel Diode, K. Hennings. "Nach. Z." Sept. 1959. 6 pp. A diode with an electrode spacing variable by means of a bi-metal system, has been manufactured in order to permit the measurements of the electronic admittance of a plan-parallel diode over the widest possible range of electrode spacing, frequency and current density under otherwise equal static operational conditions. The measurements cover electrode specings between 40 μ and 1 m.m., current density values of up to 200 ma/sqcm and anode voltages of up to —30 v at the frequencies 1.600, 2.400 and 4.000 MC. (Germany.)

A Survey of Temperature Measuring Techniques, W. A. Seatherton. "Brit. C.&E." Oct. 1959. 10 pp. Temperature is one of the most important process variables encountered in modern laboratory and industrial processes, and there is a constant demand for improved methods of measurement and control. In consequence of this, an extremely wide range of measuring techniques has been evolved. This article briefly surveys these numerous techniques and a number of charts are included which it is hoped will help the user to select the best type of instrument for a given application. (England.)

RADAR, NAVIGATION

An All-Wave Indicating Direction Finder Employing the Doppler Effect, M. Wachter. "Nach. Z." Sept. 1959. 3 pp. An all-wave indicating direction finder with interchangeable units has been designed in order to fulfill for all the different frequency bands in the most universal and rational manner the demands for dual channel indicating direction finders as imposed by navigation, radio supervision, and meteorology (storm DF). The equipment consists of a basic unit containing the indicator unit, the i-f amplifier, the monitoring unit and the correcting networks required for the alignment of the amplifier channels. The basic unit is common to all frequency bands. The equipment also comprises various interchangeable units, containing the special circuits for the various frequency ranges. The exchanging of the units for frequency range changes can be avoided by an additional remote control unit. (Germany.)

Instruments for Inertial Navigation, Part 2: Applications, D. J. Cashmore and C. N. Gordon. "Brit. C.&E." Oct. 1959. 5 pp. In the previous article, the principles of the construction and operation of instruments for inertial navigation were described. The two basic instruments are gyroscopes and accelerometers, together with their integrators; this article considers how these instruments are combined into complete inertial navigation systems. It is suggested that a major break-through in instrument design may be necessary before further spectacular advances can be made. (England.)

Instruments for Inertial Navigation, Part I—Principles and Components, D. J. Cashmore and C. N. Gordon. "Brit. C.&E." Aug./Sept. 1959. 5 pp. This is the first two articles in which a survey is made of inertial navigation instruments. Part II will cover some applications of these techniques. (England.)

Communications for the Thames Navigation Service. "Brit. C.&E." Aug./Sept. 1959. 4 pp. A comprehensive radiotelephone system is now being operated by the Port of London Authority as a service to Thames shipping between London Bridge and the Nore. Surveillance radar is also included in the scheme. (England.)

Infra-Red Navigation Aids. "Brit. C.&E." Aug./Sept. 1959. 7 pp. This article reviews some experimental work that is being carried out in this country to establish a short-range infra-red navigation system for use in natural fogs and mists. Transmissions are within the range 4 to 14 microns. The principal need now is for sensitive, short time-constant, infra-red image forming devices for use in the receivers. (England.)

'Autoland' A Blind Landing System for Aircraft. "El. Eng." Sept. 1959. 4 pp. (England.)

SEMICONDUCTORS

Use of Transistors to Increase the Efficiency of Reversible DC Magnetic Amplifiers, M. A. Rosenblatt, G. V. Subbotina. "Auto. i Tel." Sept. 1959. 6 pp. It is shown that the use of two transistors in the output circuit of a reversible dc magnetic amplifier can greatly increase the efficiency of such amplifiers. (U.S.S.R.)

The Variode, A New Semiconductor Component, G. Zielasek. "El. Rund." Oct. 1959. Lately the so-called variode regulator is being used in control boxes of motor cars for improved and simplified current regulation of dynamos. The heart of this device is the semiconductor component developed especially for this purpose, i.e. the variode which essentially is a semiconductor crystal of, say germanium having a p-n junction. Owing to a suitably chosen impurity concentration, the current/voltage characteristic of this component has an extremely steep forward slope with a relatively sharp knee reminding of a Zener-diode characteristic. However, an important difference between a variode and a Zener diode exists: the former is operated in forward direction, the latter in reverse. Moreover, the voltage drop across a Zener is at least 10 times higher than of a variode. The variode characteristic is dependent on temperature; this, however, is desirable for the stated application. (Germany.)

Drift Transistor Simplified Electrical Characterization, J. te Winkel. "E. & R. Eng." Aug. 1959. 9 pp. Equivalent circuits for a drift transistor are developed starting from a set of parameters derived from the physical principles underlying the device. It is shown what approximations are possible if limited frequency ranges or large values of the drift field are considered. Further simplifications are obtained from the introduction of suitably chosen frequency parameters. The resulting equivalent circuits appear to be simply related to those commonly used for a normal alloy transistor. The form is the same and the values of the circuit elements can be found by means of a number of multiplying factors that depend on the drift field only. These are given in graphical form. (England.)

Local Feedback in Transistor Amplifiers, H. Pfyffer. "El. Eng." Sept. 1959. 6 pp. In this article the common emitter amplifier stage is first discussed. The effects of negative feedback on gain, impedance and cut-off frequency are then calculated and theoretical calculations are compared with measured results. Some of these comparisons are illustrated graphically. (England.)

TELEVISION

Color Television in Medical Teaching, W. A. Holm. "Phil. Tech." Vol. 20, #11, 1959. 4 pp. A description is given of the closed-circuit color-television system recently installed in the Department of Medicine at the University of Marseilles for demonstrating surgical operations to audiences of 300. The camera in the operating theatre contains three photoconductive camera tubes and a zoom lens system whose focus, focal length and aperture can be remotely controlled. (Netherlands, in English.)

Automatic White and Black Level Locking for Vidicon Film Scanner, E. Sennhenn. "El. Rund." Sept. 1959. 5 pp. A control circuit is described which adjusts the white level of film scanners automatically thus balancing level fluctuations caused by varying blackening of film highlights. The circuit works through a magnetic amplifier on the film-projector lamp. For a luminous-flux change 1:3, the adjusting time is 1 to 2 s for an increase and 0.3 to 0.5 s for a decrease of the flux, depending on the lamp-voltage range preadjusted. The automatic black-level control keeps the signal of the darkest picture spot at a constant-voltage output signal. A special circuit locks the darkest-point signal to the gradation characteristic. (Germany.)

Operational Experiences with New Coaxial Cable Television Links, R. Rasch. "Nach. Z." Sept. 1959. 5 pp. In the new German coaxial cable T.V. link system T.V. 1, the amplitude of the transmitted T.V. signals is controlled automatically by special pilot frequencies as in carrier frequency telephone links. The selective band stop filters required at both ends of a transmission link for these pilot frequencies produce an interference in the picture, known as ringing. The effect of this ringing on the transmitted test patterns and test signals is described. Due to the transmission system T.V. 1, the T.V. signals obtain certain properties which are shown by oscillograms of test signals. (Germany.)

The Present State of Television Broadcasting at Home and Abroad, Hans Rindfleisch. "Rundfunk" #5. Oct. 1959. 9 pp. The report begins with a review of the expanse of the different television standards and the density of television viewers in the various countries of the world. As regards the German Federal Republic the development of the

Sources

existing transmitter network is shown. Its proposed extension, as well as the extent of the area covered, is discussed. After looking at the Eurovision network, the author discusses the prospects for a further extension of international and intercontinental television transmissions. (Germany.)

A New Television Studio of the NWRV at Hamburg, V. Schadwinkel, F. Naupert, E. Struss. "Rundfunk" #5, Oct. 1959. 7 pp. A television studio was recently taken into service in the grounds of the Real-Film-Gesellschaft at Hamburg-Wandsbek. This studio is to be used for a limited time and will suplement the studio capacity of the NWRV at Hamburg-Lokstedt. The building is the property of the Real-Film-Gesellschaft and rented to the NDR. The technical equipment was built by the planning groups of the NDR and the NWRV in collaboration with the television operational staff and with outside firms. (Germany.)

System Design Criteria for Space Television, A. J. Viterbi. "J. Bire." Sept. 1959. 10 pp. A narrow band television system for relaying to earth images of the planets is described. The principal consideration is the necessity of communicating over extremely long ranges. Because of the resulting high noise environment, the channel bandwidth is severely restricted. Bandwidth compression is achieved by storing the video signal on magnetic tape or photographic film and transmitting at a reduced information rate. (England.)

The Use of Television for the Microscopical Examination of Radioactive Metals, E. C. Sykes. "J. Bire." Sept. 1959. 6 pp. Closed circuit television for relaying the image produced by remotely controlled microscopes enclosed within thick lead shields, and used for the examination of highly radioactive irradiated fissile materials, e.g. uranium 235, is described. Brief details are given of two installations incorporating respectively c.p.s. emitron, and image orthicon camera chains. A device is described which accurately measures the microstructural features displayed on the monitor screens. The advantages and disadvantages of television compared with optical viewing are discussed, and brief mention is made of experiments with television for general remote handling. (England.)

Communications in Independent Television, L. F. Mathews. "J. Bire." Sept. 1959. 8 pp. The effect of expanding demand on the design of a network for the conveyance of vision sound and the control of programmes within a television programme organization is described. Reference is made to problems associated with exchange of programmes with similar organizations. Outside broadcast radio links and methods adopted whereby a number of contractors can participate in a composite link are discussed. A new microwave link for monitoring purposes is described, with particular reference to the automatic switching and monitoring facilities carried out over an associated u.h.f. link. Uses of the communication systems other than for scheduled programme transmission are described, and the paper concludes with a short account of future plans and developments. (England.)

Two Co-Ordinate Colour. "E. & R. Eng." Aug. 1959. 4 pp. (England.)

The Film-Scanning Equipment of the Nord- and Westdeutscher Rundfunkverband at Hambury, Von Udo Stepputat. "Rundfunk." Aug. 1959. 12 pp. The author describes the development of the art of television film transmission in the Nord- and Westdeutscher Rundfunkverband at Hamburg during the past five years. Corresponding to the continually increasing part played by films in television programmes, new equipment and methods for making and processing films have been developed, especially for 16 mm-film. Outside-broadcast vehicles have been equipped for films. The author describes the effect of the film stock on the quality of the television picture and shows the superiority of several film over the negative-positive method. In discussing film recording and re-

Sources

producing technique, the author compares the technical properties of the equipment at present in use. (Germany)

The Functioning and Utilization of Special Effects Equipment in Television, Von Gerhard Stump. "Rundfunk." Aug. 1959. 4 pp. The paper describes the working principles of a video mixing unit such as is used in the main in German television studio centers. Special mention is made of an "inlay" device by means of which it is possible to produce a considerable number of special effects, and the application of these effects is described. (Germany)

A New Method for the Suppression of Low-Frequency Noise on Television Cables., R. Rasch. "Nach. Z." 3 pp. Noise due to mains hum is found frequently in video-frequency TV transmissions. The paper describes a special circuit for removing such noise. (Germany)

The Design of Dual-Standard Television Receivers for the French and C.C.I.R. Television Systems, C. J. Hall. "J. BIRE." Aug. 1959. 12 pp. There are several regions near the borders of France with Germany, Switzerland and Italy where a demand exists for a television receiver capable of functioning on either the French or C.C.I.R. systems. An inspection of typical television receivers for each of the two systems shows that there are essential differences in all parts of the circuit except the power supply, frame time-base and audio frequency sections. Consequently direct switching from one system to the other could involve a very large number of switching operations, including many in critical circuits where switching may introduce difficulties. (England)

Assessment of X-Radiation from Television Receivers, A. Ciuciura. "J. BIRE." Aug. 1959. 14 pp. The possibility of predicting, at the design stage, the X-radiation properties of a particular receiver under development is achieved by establishing X-ray properties of cathode-ray tubes in terms of their spread, e.h.t., and beam current and by defining properties of e.h.t. supplies in terms of mean potential spread and internal impedance. (England).

TRANSMISSION

Investigations Relating to Noise Reduction by Means of Pre-emphasis and De-emphasis in Broadcast Transmissions, W. von Guttenberg, and H. Hochrath. "Nach. Z." Sept. 1959. 8 pp. The peak power levels in broadcast transmissions by means of carrier frequency systems are increased by pre-emphasis curves which give an appreciable noise reduction with low costs for their realization. When this is to be avoided by means of more complicated pre-emphasis curves, a white noise reduction of only 3 db is obtained and certain operational disadvantages must be faced. Consequently, pre-emphasis circuits are not a suitable means for the installation of low noise broadcast landlines. (Germany.)

New Measurements to Determine the Transmission Characteristics of Objectives from the Viewpoint of Television Engineering, Dieter Frenzel. "Rundfunk" #5, Oct. 1959. 7 pp. The article describes a new measuring method for the examination of objectives that takes into account only the overall effect of objective faults on the quality of the television picture. By means of the oscillograms obtained from the measurements, the curves of the limiting frequency in relation to the iris setting and the angle of inclination of the principal ray are obtained and represented in graphic form. This limiting frequency serves as a measure of the effect of the objective on the quality of the television picture. (Germany.)

Limits of Trick Stereophony with Sub-threshold, Pilot Frequencies, F. Enkel. "El Rund." Oct. 1959. 3 pp. Trick stereophony is the

Sources

transmission of spatial sound configurations through a channel by pilot frequencies. In this investigation, the pilot frequencies are inaudibly located in the noise level of the transmission system. This method requires but an extremely small additional information capacity closely approaching the theoretical limit. On account of the advantages in transmission, an attempt is made, using the example of a model, to find how far this technique may go to approximate isomorphic stereophony. (Germany.)

Waveguide as a Long Distance Communication Medium, A. E. Karbowiak. "El Eng." Sept. 1959. 6 pp. A discussion is given of a communication system utilizing waveguide as the communication medium. All the more important aspects of such a communication system are analyzed and the properties of various types of waveguide are discussed in some detail. It is shown that although plain metallic waveguides are unsuitable for long distance communication, waveguides of special construction (either dielectric coated or helical waveguides of appropriate proportions) can be designed to fulfill any reasonable practical requirements and that a communication system of extremely wide bandwidth can be constructed. (England.)

TUBES

The Reliability of Electronic Valves in Practical Applications, W. Chladek. "Nach. Z." Sept. 1959. 7 pp. The knowledge of the absolute number of failures and of the fluctuations of this number are required for statements relating to the failure rate of electronic valves. Investigations relating to this subject have been carried out at many places and several authors have reported their results. Some of these authors have treated also the theoretical principles. A selection of these reports are compared with figures of our experience. Conclusions relating to the reliability of equipment fitted with valves can be drawn by means of calculations with the aid of these figures for the failure rate. It is possible to take into this calculation of the failure rate, certain properties of the circuit. The usefulness of the method is proved with the aid of an example. (Germany.)

The Performance and Design of a Titanium Getter Pump of High Pumping Speed, L. Holland and L. Laurenson. "Vide" #81, 1959. 10 pp. The production of electronic tubes with large degassing areas such as magnetrons, etc., has encouraged the development of self-contained getter-ion pumps. Titanium is currently used as the gettering material. The difficulties in evaporating titanium and the methods employed by the authors and others are discussed. A titanium droplet vapor source is described, for use in a getter-ion pump of exceptionally large pumping speed. (France, in English.)

Investigations on Electron Gun for Flat Beams, G. Bolz. "Nach Z." Sept. 1959. 3 pp. An optimum gun for flat electron beams is calculated and its design is described for the purpose of designing the focussing electrodes. A solution of the equation for the potentials is given in the form of converging series. Experimental results are reported. (Germany.)

* * *

Tech Data

for Engineers

Acceptance Tester

A 4-page booklet, 321A, describes the features and performance of an automatic acceptance tester for TACAN transceivers. Marketing Dept., Electronics Div., Stromberg-Carlson, Rochester 3, N. Y.

Circle 247 on Inquiry Card

Power Supply

Bulletin 104 from Dynatronics, Inc., Box 2566, Orlando, Fla., describes an all solid state dc power supply featuring regulated output of ±100 to 250 v. with a 6 a continuous load. Unit is designed for mounting in standard 19 in. relay racks.

Circle 248 on Inquiry Card

Contact Relays

Mercury-wetted contact relays are described in Catalog 201 issued by C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Ill. Relay types are for both single- and multi-element operation, biased with permanent magnets, or adjustable to provide single-side-stable, bi-stable, or chopper characteristics.

Circle 249 on Inquiry Card

Capacitors

An 8-page catalog describes a complete line of ceramic disc and plate capacitors. Includes specs and tech data. Electra Mfg. Co., 4051 Broadway, Kansas City, Mo.

Circle 250 on Inquiry Card

Tech Data

for Engineers

Interrupting Capacity

A revised version of the "Interrupting Capacity Chart," Chart SA-8163-A, is available from Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa. The chart enables users of circuit breakers to select and order the proper breaker for each application. Revision includes Westinghouse breakers JK, JKL, and the four Mark 75's.

Circle 251 on Inquiry Card

Variable Resistors

Data sheet from Chicago Telephone Supply Corp., Elkhart, Ind., gives dimensional drawings and complete technical data on its new line of ¾ in. dia. miniature preset wirewound, ½ to 5000 ohms resistance range, variable resistors.

Circle 252 on Inquiry Card

Protective Coatings

"How to Use HumiSeal Protective Surface Coatings in Electronic Applications" is the subject of a 20-page booklet released by Columbia Technical Corp., 61-05 31st Ave., Woodside 77, N. Y. Charts and slide rule settings are also included.

Circle 253 on Inquiry Card

Transducers

An 8-page, 3-color, Short Form Catalog describes the line of instruments available from Cox Instruments Div., George L. Nankervis Co., 15300 Fullerton, Detroit 27, Mich. The line consists of flow measuring transducers, associated electronic readout equipment, and flow calibrating devices.

Circle 254 on Inquiry Card

Thermoplastics

Application sheets No.'s 101, 102, 105, 109, from Allied Nucleonics Corp., Plastics Div., 2421 Blanding Ave., Alameda, Calif., describe applications of Kel-F thermoplastic, including seals, extrusions, coil forms and others. Included are mechanical and electrical characteristics.

Circle 255 on Inquiry Card

Technical Publication

A new technical publication, SPAN, has been introduced by the Semiconductor Div. of Hoffman Electronics Corp., 1001 Arden Dr., El Monte, Calif. The first issue, a bi-monthly publication, contains technical data and application information on silicon semiconductor devices.

Circle 256 on Inquiry Card

Circle 502 on "Opportunities" Inquiry Card

Personals

Carroll R. Miner has been appointed Chief Engineer of Hoffman Electronic Corp.'s Consumer Products Div.

Dr. George K. Hess Jr., who has been on the staff of the Los Alamos Scientific Laboratory, has been appointed as a Staff Assistant to C. M. Edwards, Associate Director, Technical, of the Research Laboratories Div., Bendix Aviation Corp.

Nicolas G. Sakiotis has been appointed Project Leader in the Microwave Applications Lab. of the Motorola Solid State Electronics Dept. He was formerly with the Naval Research Laboratory.

The appointment of **Ray Lane** to the post of Director of Research & Engineering has been announced by Pyramid Electric Co.

George J. Brown is now Director of Engineering of the Instrument Div., Bourns, Inc., Riverside, Calif. He was formerly Chief Engineer at Statham Instruments, Inc.

G. J. Brown

J. G. Frayne

Appointment of **Dr. John G. Frayne** as Manager of Development Engineering at Datalab Div., Consolidated Electrodynamics Corp., has been announced.

J. Brendan Forrest joins CBS Electronics as a Physicist. He was previously a Technical Information Analyst with the Westinghouse Atomic Power Div.

Charles J. Hirsch has been appointed Administrative Engineer on the staff of Dr. George H. Brown, Vice President, Engineering, Radio Corp. of America.

Two new appointments at General Transistor Corp.'s Rhode Island Facility are **Frank Garbis**, Vice President, Director of Engineering, and **A. Charles Emanuel**, Vice President, Director of Manufacturing. (These appointments were incorrectly reported in October as being at General Transistor's main plant in Jamaica, N. Y.)

Personals

Four Field Engineers have been appointed by Metals & Controls Div., Texas Instruments, Incorporated. Those appointed are: **Warren M. Ide, Leon J. Moules, Paul J. Keller, Jr.,** and **John Schmidt.**

Robert W. Deichert to Engineering Manager for Scientific Instruments at the Industrial Electronics Div., Allen B. Du Mont Labs., Inc.

Ronald Compton has been named Sr. Engineer for computer design at the main plant of Bendix Computer Div., Los Angeles.

William E. Seaman is now Chief Engineer at Midwestern Instruments, Inc.

Dr. Joseph Kukel has been appointed the new position of Chief Engineer, Instruments and Systems at Daystrom Pacific Div., Daystrom, Inc.

Fairchild Semiconductor Corp. has appointed four engineers to supervisory positions in the Engineering Dept. **Robert Norman** will head the Device Evaluation section; **William Hafner** is Head, Electronic Instrumentation; **Brent Knudson** is Supervisor of the Product Specification Group; and **Baden Parker,** is Supervisor of the Design group in Electronic Instrumentation.

L. Merle Wilson is now Chief Engineer of the Industrial Systems Dept., Consolidated Systems Corp.

Dr. Walter R. G. Baker, President, Syracuse Univ. Research Corp., has been named recipient of the David Sarnoff Gold Medal Award of the SMPTE for meritorious achievement in TV engineering.

George H. Kunstadt has been appointed Technical Director of the Ground Support Equipment Dept. in The Martin Co.'s Baltimore Div. He was formerly Engineering Projects Manager in the Airborne Systems Dept., Defense Electronic Products Div.

Robert W. Carlson has been appointed to the position of Director of Military Electronics Engineering, at the Wurlitzer Co. He was formerly associated with Bell Aircraft Corp.

Jerome Z. Kunze is now Eastern Sales Manager, Components, at the Reeves Instrument Corp., a subsidiary of Dynamics Corp. of America.

News of Reps

Avionic Engineering Sales Co., 226 Ida, P. O. Box 786, Wichita, Kans., is a new manufacturers' rep firm providing representation for manufacturers of electronic components and sub-systems for the aircraft industries.

The Marshall Co., Buffalo, N. Y., has been appointed by Bishop Mfg. Corp. as sales rep in the western portion of New York State.

Visirecord of Canada, Ltd., has been appointed Canadian distributor for American Electronics Peripheral Data Processing Machines.

Electro-Pulse, Inc., has appointed **Parrish Electronics**, Denver, Colo., sales rep for Colorado, New Mexico, Utah, Wyoming, and Southeast Idaho.

The Industrial Div., The Birtcher Corp., has appointed **"ELCOM" Electronic Component Sales Inc.**, Denver, Colo., as rep in Colorado, Utah, Wyoming, Montana and Idaho.

Motorola Semiconductor Div. has named **James S. LaRue** as Military Relations rep. He was formerly with the U. S. Air Force Electronic Components Lab.

McCarthy Associates, Inc., electronics manufacturers' reps, Pasadena, Calif., have promoted **Ron Klass** to the newly created position of Business Manager and Treasurer.

William Menezes is now on the sales staff of Hutmacher Assoc., electronic rep firm covering the Illinois-Wisconsin territory.

McCarthy Associates, Inc., Pasadena, Calif., have been appointed rep for Cubic Corp. and Wayne Kerr Corp. They will handle Cubic's digital instruments in So. California, Arizona and Nevada, and a line of electronic instruments for Wayne Kerr in California, Arizona and Nevada.

The newly finished offices of **Williams & Associates**, electronics manufacturers' rep, are now open at 3221 Silver Ave., S. E., Albuquerque, N. M. The expansion doubles the size of the firm's facilities.

The Polytechnic Research & Development Co., Inc., has appointed **George Gostenhofer & Assoc., Inc.**, Waltham, Mass., as rep in Massachusetts, Connecticut, Vermont, New Hampshire, Maine and Rhode Island.

News of Reps

The **O. F. Masin Co.**, Pelham, N. Y., has been appointed by Ace Electronics Assoc., Inc., as rep in the Metropolitan New York area.

Nelson E. Thomas and Assoc., New Orleans, La., has been appointed Southern rep for Entron, Inc.

The Amerelay Corp. has appointed **R. T. Mathews & Co.**, Ft. Wayne, Ind., as rep in Kentucky, Wisconsin, Indiana and Northern Illinois.

Roy H. Cooley Assoc., Seattle, Wash., has been appointed rep for Washington and Oregon by Task Corp.

The Robison Co., Torrance, Calif., has been named rep in California for The Milton Ross Metals Co. and The Ross Manufacturing Co.

The newly formed **Carey-Wolf Co.**, Ft. Worth, is now rep for Assembly Products, Inc., in Texas, Oklahoma, Arkansas and Louisiana.

Robert W. Peters Co., Cleveland, Ohio, is now rep for Clear Beam Antenna Corp. in Ohio, West Virginia and Eastern Pennsylvania. **Felleisen Assoc.**, Chicago, Ill., is Clear Beam rep in Illinois, Wisconsin, Minnesota, North Dakota and South Dakota.

Polyphase Instrument Co. has appointed the **J. S. Kempf Co.**, Inglewood, Calif., as West Coast sales rep.

Alfred Electronics, Inc., has appointed **George Gostenhofer & Assoc., Inc.**, Waltham, Mass., as engineering sales rep in the New England area.

The appointment of **Stanley K. Wallace, Assoc., Inc.**, Lutz, Fla., as rep for Chemtronics Inc., has been announced. They will cover Alabama, Florida, Georgia, Mississippi, North and South Carolina and Tennessee.

John W. Murphy, Seekonk, Mass., is now rep for Uniform Tubes, Inc., in New England.

The Flow Corp. has appointed 3 new engineering sales reps. **Broger Instrument Sales Co.**, Brookline, Mass., for the New England territory; **Martin Electronic Marketing Assoc., Inc.**, New York City, for Eastern Pennsylvania, New Jersey and the Greater New York area, and **Burt C. Porter Co.**, Seattle, Wash., for Washington, Oregon, Idaho, Montana and Alaska.

Ken Steinke Sales Co., Milwaukee, Wis., is now rep for Pyramid Electric Co.

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

Engineer Enrollment Dip Tied To "Sputnik Fever"

Dean Dale R. Corson, Cornell College of Engineering, in a talk to the University Council, blamed the fall-off in engineering enrollment for the second year in a row, on "Sputnik Fever" which diverted many potential engineers to science.

Last year the enrollment drop averaged 11%. However, the quality of the freshman engineers, says Dean Corson, is higher than normal. This, too, he attributed to the increased interest in science and engineering generated by the sputniks.

The scientific achievements of the satellites he believes to be overestimated. The advancements, he claims, are engineering achievements although some of the measurements which have been made with the satellites have scientific interest.

The drop comes in a year when graduates are getting the largest starting salaries in history. Cornell University electrical engineering graduates averaged $538; graduates in engineering physics $570; chemical engineers, $543; and metallurgical engineers, $539. Of 272

(*Continued on page* 251)

Management Misuses Engineering Talent, Engineers Complain

A fundamental and unresolved conflict between the scientific mind and the management mind is disclosed by a study made by Opinion Research Corp., Research Park, Princeton, N. J. The study involved interviews with 622 scientists and engineers and 105 managers in six major companies engaged in scientific research.

The study revealed a conflict between management's need to sell its products and make a profit and a basic quest for knowledge by the technical men. It disclosed a lack of mutual respect between the groups, with each group tending to evaluate the other's accomplishments and rewards by its own standards.

The engineers and scientists indicated a desire for a type of professional status and freedom which is difficult to meet in a corporation and is more appropriate to private, professional practice, or university life.

Of the scientists and engineers interviewed 72% complained that management misuses their talents, 71% that their companies forced them to overspecialize, and 67% believed that getting ahead in management is more a matter of politics than knowledge.

They complained that they were underpaid (80%), and that corporate pressures did not permit freedom to "work in their own way" (75%). While 74% listed sales and profits as primary goals of their companies, less that 50% said they shared these goals.

ORC's research suggested several constructive steps to deal with the problem. These include a need for managers to place greater emphasis on interpreting their everyday decisions to the technical man and a need for more realism during college training and recruiting so that the future scientist or engineer may know what to expect of corporate life.

MIT Gets $9 Million For Engineering Education

A $9,275,000 grant from the Ford Foundation will be used by the Massachusetts Institute of Technology in making extensive advances in engineering education, said Dr. Julius A. Stratton, M.I.T. President.

The funds will support a program of development and innovation in the School of Engineering under Dr. Gordon S. Brown. Seven major professorships are to be endowed. Wholly new curricula will be introduced, new forms of instructional laboratory equipment will be created, and there will be an intensive effort to educate teachers as well as engineers for the opportunities and responsibilities of the age.

(*Continued on page* 252)

NEW PLANT

Herold Radio & Electronics Corp. located this new, $2,000,000 plant in New York City to take advantage of the large supply of skilled and semi-skilled labor available in that area.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 201.

By VERNON D. WALKER
Vice President, Administration
Marc Shiowitz & Associates, Inc.
Gardena, Calif.

He's a Specialist Too!

. . . The Systems Engineer

The systems engineer is an unusual individual—a specialist without a specialty. His personal traits must include intuition, practicality, leadership and initiative. Instead of knowledge in depth of a small segment of the field, he has a broad knowledge of many segments. He is the most sought-after engineer in today's market.

FOR the past 20 years, new devices and techniques have been evolved from the electronics industry in much the same manner as crops from a farmer's field. Each was developed to satisfy a particular need with little regard for its possible relationship with others.

In recent years a group of people who do not actually develop the devices and techniques have become an important factor in the electronics industry. These are the people who supply the specialized talent needed to integrate the available components, equipment, and techniques into operational systems. They are specialists with no real specialty at all; instead of a knowledge in depth of a small segment of the field, they have a broad knowledge of many segments of the field. Their broad title: Systems Engineer. Their function: largely analytic and catalytic.

Today, more and more manufacturers are building toward electronic systems work. They are finding that devices and equipment which individually satisfy their design requirements are now merely parts of a much more complex entity—the system. Unfortunately, apparently satisfactory operation of each of these parts will not assure satisfactory operation of the system.

System Creation

The creation of a system is a complex problem, far above the mere combination of components. An important consideration is the consequence of the dynamic, economic and logistic interaction of the individual entities which make up the system. The average engineer is specialized to a great degree. Undue concern with the intricacies of his specialization precludes the characteristics of the good systems engineer.

While the industry's trend toward more systems work does create a whole new set of requirements, it is, on the whole, a desirable direction in which to be headed. The great demand for systems in military, commercial and industrial applications has opened the door to new opportunity in the industry. For the small manufacturer, the need for "one-of-a-kind" systems means new opportunities for business that does not tempt large company competition because volume production is not involved. To the larger firm, the expansion of the systems concept means a new possibility for solution of a company's own problems in addition to increased markets for its products.

Problems of the New Field

However, entry into this bright new field does have its problems. Possibly the major concern of any company entertaining systems engineering ideas, is where to obtain the basic background of system techniques. Obviously, there is a crying need for the services of the systems engineer—a man experienced in analyzing the overall problem, synthesizing a system diagram, selecting and organizing a series of components, equipments, and sub-systems to achieve a specific overall function. Depending on the economics and company policy, this need can be satisfied in one of three ways:

1. By establishing a systems engineering function or department within the company.

2. By sub-contracting all or most systems engineering work.
3. By obtaining the services of a consulting systems engineering firm.

Each of these solutions has its own definite advantages and disadvantages.

The establishment of an internal department raises problems of overhead, turnover, the difficulty of finding qualified personnel and wasting much of their time on sub-professional work. At the same time, however, this method can provide maximum communication and management control.

In sub-contracting systems engineering work, there is a possibility of drastic scheduling conflicts. In this case, though, the company does have definite commitments and is relieved of many personnel and administrative problems.

In the case of the consulting firm, there is also the possibility of schedule conflicts. There is also the matter of responsibility. Consultants must be screened and evaluated carefully. On the other side of the ledger is the stature and proven ability of a qualified consulting firm. Also to be considered is the fact that the hiring of a consultant makes for flexibility and maximum utilization of technical ability—minus the responsibilities for continuing payroll and fixed overhead.

No matter which avenue is chosen for accomplishing the system engineering phase of a project, there will remain at least one common denominator: The importance of the traits and abilities of the individual engineer who is assigned to the job at hand. Therefore, it is basic to the entire aproach to systems work to have a thorough understanding of what it takes to make a good systems engineer. You must know what you can expect from him and what you should be prepared to give to him.

What to Look For

The ideal systems engineer is a very unusual individual. From the standpoint of training and experience prior to engaging in systems work, there is no common pattern. His background is just as apt to be mathematics or physics as engineering. Naturally, a good educational background in the areas of mathematics, science and engineering is an asset, but the knowledge can also be acquired by experience or can be self-taught.

His personal traits must include intuition, practicality, leadership and initiative. He must be well-grounded in fundamentals and have a working knowledge of several technologies. He must have the ability to communicate both orally and in writing. Above all, he must remain a generalist in a world of intensifying specialization.

What to Expect

The characteristic which distinguishes system theory is the preoccupation of the system designer with the whole entity. He is concerned with the analysis and design of external characteristics of the whole system and with components of the system, particularly as they pertain to the overall system characteristics.

Aside from the strictly technical aspects of the system, expect him to investigate the political, economic and marketing characteristics of the proposed system. These, too, are part and parcel of his domain.

Here are a few additional checkpoints for services which you should expect from a systems engineer:

a. Supervise preliminary engineering.
b. Plan, analyze and develop overall project concepts.
c. Supervise (but not perform) detailed engineering.
d. Be responsible for the development, design and fabrication of working models or prototypes.
e. Be responsible for final engineering, including the testing, modification and setting up of maintenance procedures.

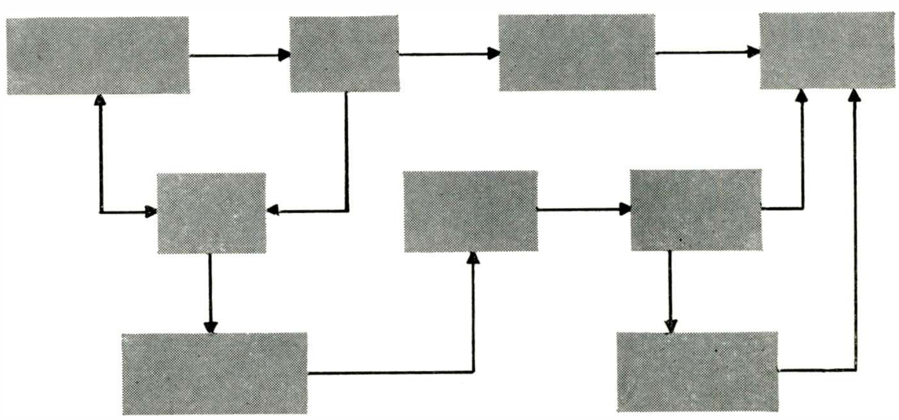
Expect him to produce the proposed system on time and within budget limitations, but do not expect him to work miracles.

He will be able to work with all types of specialists, as the basic knowledge of specialities is his stock in trade, but he will not normally be able to teach the specialist new tricks. For example: He is expected to know that an amplifier of specific characteristics and size limitations can be built—yet he cannot be expected to know how to build the amplifier.

For all of the individuality and leadership you are looking for in a systems engineer, it is also important that you pick a man who knows how to function as part of a team. He will be working with specialists in a number of fields. Each of these people is likely to have his own specialized knowledge, reputation and experience. Each engineer assigned to a systems project should be accorded the respect and attention due him. Everyone needs a feeling of accomplishment. Recognition is due every member of an engineering team. Your systems engineer should know these things and conduct himself in a manner which creates harmony among all members of the staff. He must be able to generate an atmosphere which sustains this harmony throughout the life of a project.

(Continued on following page)

Today systems engineers are responsible for assembling a mass of "black boxes," all of them properly integrated, to form a system.



The Systems Engineer *(Concluded)*

Relationship with the Staff

Much like the telephone switchboard, the systems engineer will act as a clearing house and channeling center for the technical knowledge of your specialized engineering staff.

It is his job to know what is needed to complement the system, and to possess the personality traits to draw the best from the specialist.

His primary responsibility is the system as a whole. Since this task embodies both management and technical responsibility, his authority must supercede that of the individual specialist. While his technical knowledge of any one specialty may not approach that of the specialist, his overall knowledge of system techniques will enable him to handle efficiently the specialist's problems.

His developed ability to analyze, decide, organize and direct the entire systems project will make him the focal point of all engineering activity.

Do's and Don'ts for Management

1. DO place your confidence in his ability.

2. DON'T expect the impossible of him.

3. DO provide him with the technical and clerical aid necessary to the satisfactory completion of the project.

4. DON'T withhold the authority he needs to accomplish his task.

5. DO appreciate him—his responsibilities are many.

6. DO continue to recognize the importance of and encourage the creative efforts of the specialized engineers on your staff.

7. DON'T be surprised when you learn that your regular staff engineers have greater knowledge than the systems man in their specialized areas. This is as it should be. It will do the specialized man a world of good to know of this situation and to realize that his management recognizes his abilities.

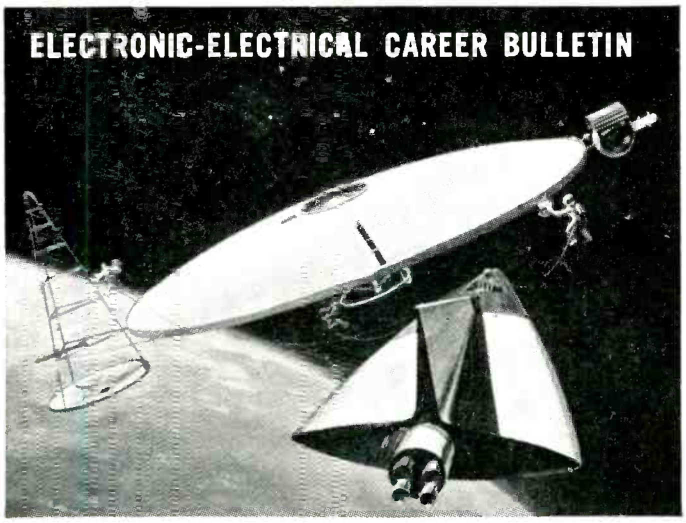
8. DO protect and safeguard the morale of the rest of your engineering staff. Be sure all employees have a clear-cut idea of what the systems engineer will be doing. Above all, make it clear that the stature and value of individual engineers will not be affected by the presence of a systems man.

9. DO expect the systems engineer to state a proposition fully and to live within it.

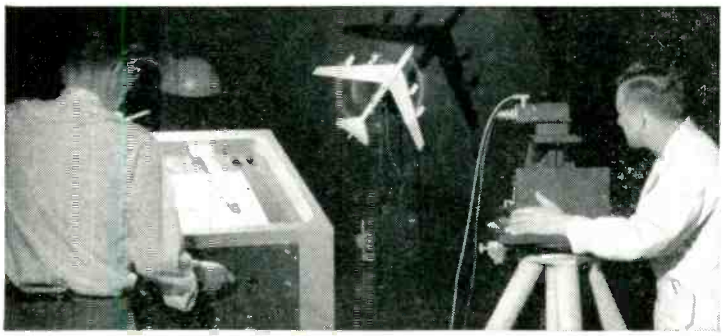
All in all, a good systems engineer is a pretty rare individual. He stands alone, a generalist in a world full of specialists. His responsibility is that of organizing the activity of many fields to best benefit a single entity—the system.

* * *

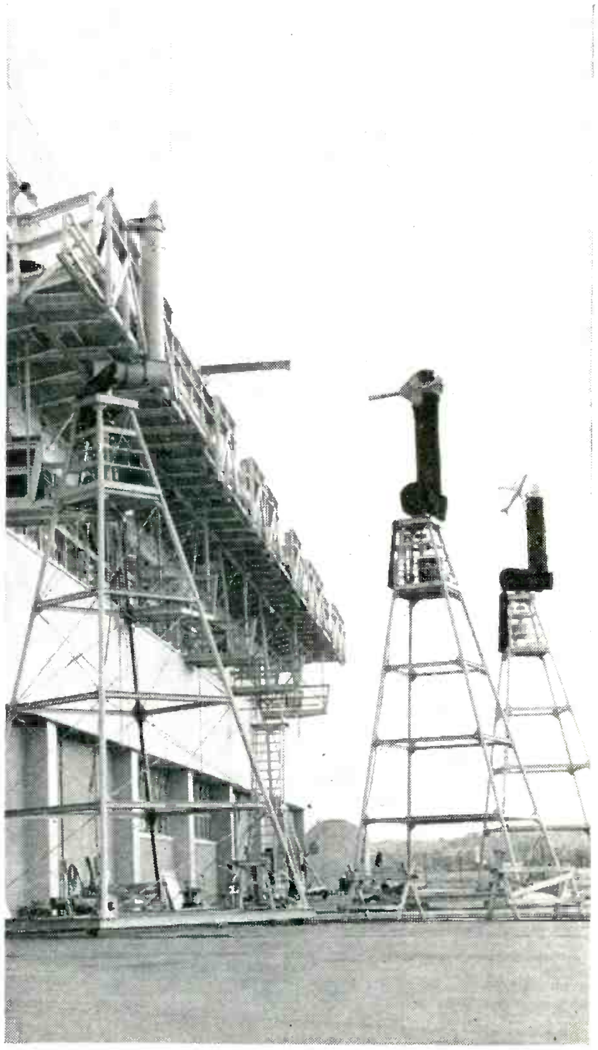
 Circle 504 on "Opportunities" Inquiry Card See the GE HMED advertisement on pages 244-245



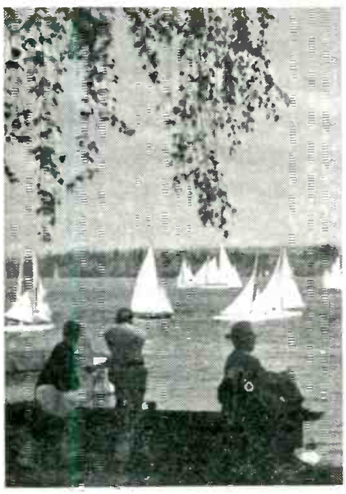
MARS VEHICLE. Drawing, based on Boeing study, of space vehicle designed for launching from orbiting platform for reconnaissance flight to Mars and return. Lunar, orbital and interplanetary system studies, and expanding programs such as the advanced Minuteman solid-propellant ICBM, are typical of challenging, long-range assignments Boeing offers electronic-electrical engineers.



DARK TUNNEL. View in 100-foot dark tunnel, part of extensive Boeing infrared research and development facilities. Boeing investigations include use of infrared, visible and ultra-violet techniques for use in communication, navigation, detection and guidance at altitudes above tropopause. IR systems, inertial navigation, electrical power systems for satellites, shockwave radiation and refraction and irdome heating are other areas of assignments open at Boeing.



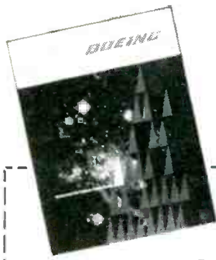
ANTENNA PATTERN RANGE, with movable towers capable of handling models up to 1000 pounds. Boeing has openings in ECM antenna development, and in gas, solid and liquid dielectric research, as well as large-aperture antennas for ASMs, orbital vehicles and airborne warning systems. Other openings are available in instrumentation, missile guidance and control.



SEATTLE area, boating capital of U.S., offers world-famous recreational facilities. Fresh and salt water boating and fishing are only one hour from dramatic snow-capped mountains renowned for six-months-a year skiing. Mild year-round climate. Excellent schools and universities, cultural activities, modern housing and shopping centers. Wonderful Western living for the whole family!

ELECTRONIC-ELECTRICAL ENGINEERS

Write today for details of challenging, long-range positions available to you right now at Boeing. You'll find at Boeing a dynamic professional environment that's conducive to rapid advancement and deeply rewarding achievement.



Mr. Stanley M. Little,
Boeing Airplane Company,
P. O. Box 3822 - EIA, Seattle 24, Wash.

Send me details of electronic-electrical positions, and the booklet, "Environment for Dynamic Career Growth."

Name .... Degree(s) ....

Address ....

City .... State ....

Field of interest ....

BOEING

Seattle • Wichita • Cape Canaveral

Circle 505 on "Opportunities" Inquiry Card

*In the recent past, electronic stocks have skyrocketed—
despite the lack of justifiable earnings.
Should the small firm take advantage of the speculative public?
Can get-rich-quick ideas hamper future growth?
What should go into the prospectus?
This noted author reasons the answers to these provocative questions.*

For the Small Electronic Firm . . .

Obtaining Capital— Methods and Pitfalls

By CASPER M. BOWER
Vice President of Finance
Sealectro Corp.
139 Hoyt St., Mamaroneck, N. Y.

BEFORE we explore the problem of raising capital for the small privately-owned electronic company, we must first understand how it is measured. I therefore refer to that time-tested investment tool—the price-earnings ratio. This formula is used by investment analysts, and to a lesser extent by the public, to estimate the relationship between the market price of a share of common stock and its present or near-term earnings for each share. This ratio also carries influential weight with management seeking its first or even second-round public capital.

Many electronic company shares today are selling at from 25 to 35 and even 40 times present, or near-term earnings. Some are even well above 60 times! These multiples are, of course, the price-earnings ratios.

Some financial analysts, including myself, consider the public is paying very handsomely for the mere privilege of owning these shares. This public generosity is further emphasized by the fact that, in many instances, no dividends are being paid and distributions appear unlikely for an indefinite period.

By contrast, there are many excellent dividend paying investment grade shares with fine growth potential—that magic charm of the electronic group—which can be purchased at an average of 20 times actual or estimated earnings.

Illusory Forecasts

I regard many of these exaggerated price-earnings ratio evaluations of future earnings as rather illusory forecasts of commercial worth. This is particularly so for newly-formed companies which have yet to prove the staying-power of their earnings potential, and which depend largely on defense contracts for survival.

But whether we agree with them or not, the public's very generous evaluations of these shares depict an actual state of affairs. In this very practical light, we cannot rightfully condemn the capital-seeking actions of some financially unsophisticated managements. Attracted by the easy prospect of obtaining public funds for their companies and, concurrently, themselves becoming paper-rich overnight, they tap the public purses. There have been some very successful recent public financings of companies which own little in the way of plant, have one or two proprietary products, lack depth of engineering organization, or lastly, but most importantly, show little earnings of consequence.

In a number of instances, within a relatively short interval of hours, days, weeks, or perhaps a few months, following the underwriters initial sale of stock, the speculative hungry public vies to buy these identical shares. They rise to a level of two and three times the underwriters initial offering price. The managers of these companies, owning the majority of stock, become wealthy men indeed.

Human nature cannot be denied. And this abruptly created paper wealth coming to contemporary electronic company managements is a most powerful inducement to the still privately-owned company.

It is understandable that these firms, when faced with inevitable growing pains and shortage of working capital, find the temptation to obtain public funds irresistible.

Public Gullibility

Rightfully, you may ask—what's wrong with taking advantage of what I regard as public gullibility? Why doesn't this prove that capital raising for the small electronic company is a cinch and most assuredly without pitfalls?

After all, American entrepreneurs, historically have obtained their starting-up capital from sources prepared to share in the risks of new enterprise and, sequentially, to profit by its gains.

I reply — nothing — except that the character of the electronic business today differs substantially from that of many pristine industrial companies. With the general run of industrial companies, the initial risks of unseasoned management, the complex production problems, and the costs of identifying and establishing sales for its product mix, are rewarded at least by freedom to make as much profits as the traffic will bear. These are, of course, subject to federal income taxes, but to no important form of governmental interference.

I wonder whether the public, which stampedes to purchase the issues of teen-age electronic companies, is even partially aware of some of this industry's unusual risks and problems.

These companies function in a most dynamic industry in terms of end products and sales frequently limited to subsequent defense products.

There exists keen raiding of engineering personnel at all levels. There is a high rate of product functional obsolescence. Profit margins are fixed and yet these can be reduced by renegotiation as the dubious reward for efficiency. These are the more prominent operational problems not typical in newly-formed non-electronic enterprises.

Management Transition

Apart from the public being generally unaware of these problems or not giving them sufficient appraisal, there is also the matter of management's transition from private to partial public ownership. This carries with it a range of new duties and responsibilities to public stockholders for the funds they supply.

Are these managements prepared to abandon the all-too-frequent practice of charging many of their high-on-the-hog personal expenses to company income?

Further, whether these managements are heavily-endowed topside with engineering skills, cognizant of the need for tactful administrative direction? And are they prepared, once their companies become partially-owned by the public, to delegate authority to subordinates of equal talent but who are not original stockholders?

Obviously, these are provocative and slanted questions. And they seemingly suggest that managements of small privately-owned electronic companies avoid taking in the public as minority partners, until the various risk elements influencing this corporate life are measurable.

To a degree, these are precisely my views. Some underwriters, for example, who obtain working capital for unseasoned companies, are not adequately qualified to detect structural weaknesses in a client organization. This lack of qualification tends to prevail where the company is engaged primarily in technological activities. As a consequence, financial troubles may brew for the company and its stockholders.

A recent Securities and Exchange Commission hearing on a public financing pinpoints these observations. In this instance, the SEC, "is challenging the adequacy and accuracy of various informational disclosures contained in the firm's statement and prospectus including: Failure to summarize the speculative factors applicable to the company and its securities; and failure to disclose adequately the facts with respect to the firm's financial condition and operating results."

According to the press release bearing on this case, "SEC is requestioning the adequacy and accuracy of information with respect to the company's business, its research and development program, and the proposed use of the proceeds of the stock sale."

Reference to this case does not imply that the aforementioned accusations are typical of many past year electronic company financings. But, it is surely a warning of consequence.

Initial Capital Source

Until small electronic enterprises have attained certain qualifications, the source of capital should be the private fund organization. These qualifications include the following: maturity with respect to sales and earnings history — say within a range of $3-million to $5-million of sales and net income after taxes in the area of 5%—depth of management — fiscal and engineering organization — and a degree of product diversification.

Private fund organizations are eminently qualified to measure the broad range of risk inherent in highly technical ventures and, collaterally, can offer, and this is most vital, continuing management and financial guidance during this all important early period of growth.

And how better to conclude these comments than to quote the pithy remarks of an obviously disenchanted president of an electronic firm whose company obtained public funds in a prior era of high price-earnings multiples. He said, "If prices drop you will have a lot of disgruntled stockholders on your neck."

The final selective decision between private vs. public financing, of course, rests with the company's controlling officers, and my subsequent remarks are intended as guideposts for managements now confronted with this problem.

Private risk capital can be solicited from various sources. The Small Business Administration will, I understand, advance as much as $350,000 on a secured loan basis against contracts or real property.

In due time, when organization and personal holding company tax problems are solved, there may be many Small Business Investment Companies, specifically formed under the Small Business Administration Act for the purpose of providing risk capital at government controlled interest rates and repay-

ENGINEERS • SCIENTISTS

An Unprecedented Opportunity to Enter the Field of

LARGE SYSTEMS

with GENERAL ELECTRIC

Yesterday's systems must today be considered only "subsystems" to be integrated into a larger entity. The growing demand of the defense establishment for super-systems offers challenges of unprecedented scope to the engineering profession.

Now HMED offers able engineers an opportunity to get full exposure to this field of the future – to learn, grow and develop their capacities for systems thinking, by working with men who have been in-at-the-beginning of major systems design and integration programs.

Facts and Figures Behind Growth Opportunities Here:

At HMED you are joining an organization providing professional people with an outstanding combination of CAREER STABILITY plus INDIVIDUAL PROGRESS. In the last few years this G. E. department has *doubled* its dollar business volume; *tripled* its engineering laboratory and office space; *quadrupled* the number of its supervisors and managers, from 26 to 101, with 90% promoted from within; *quintupled* its professional engineering staff.

CUT COUPON ON DOTTED LINE

☐ **COMMUNICATIONS ENGINEERS** – To work with Propagation consultant in frequency choice versus sight configuration, and design of optimum communication and sight configuration. (BS in EE and 3 years' experience necessary)

☐ **RADAR SYSTEMS ENGINEERS**–To integrate varied data acquisition equipment into complex electronic control systems. (Advanced EE degree preferred with minimum 3 years' experience)

☐ **TELECOMMUNICATIONS ENGINEERS** – To design and develop advanced communications subsystems of ground electronic control system complex. (EE degree and 5 years' experience)

☐ **PROPAGATION CONSULTANTS**–To assist in the design, development and management of radar and communications subsystems as applicable to an air defense system. (Advanced degree in EE or Physics with 5 years' experience)

☐ **RADAR RECEIVER & VIDEO PROCESSING ENGINEERS** – To establish receiver design criteria for optimum system performance in varied environments, particularly ECM. (Advanced EE degree or equivalent and minimum 5 years' experience)

☐ **ECM SPECIALISTS** – To provide threat models and consultation to design and management engineers. (Advanced degree in EE and 3-5 years' experience)

☐ **ANTENNA AND MICROWAVE ENGINEERS** – To establish antenna design and sighting philosophies for optimised detection system performance. (Advanced EE degree and 5 years' experience)

☐ **RADAR DESIGN ENGINEERS** – To work on advanced designs and development of receivers utilizing parametric amplifiers. (BSEE and 2-4 years' experience)

☐ **PERSONNEL SELECTION AND TRAINING SPECIALISTS** – To prepare job evaluations, manning structures for complex military systems, and forecast training aid needs. (PhD or EdD required)

☐ **EQUIPMENT EVALUATION SPECIALISTS**–To solve man-machine problems, evaluate alternative components, displays, or techniques and devise simulators. (PhD in Experimental Psychology)

☐ **CABLING ENGINEERS** – To resolve varied problems in grounding and associated shielding problems of complex electronics equipments. (EE degree with minimum 2 years' experience)

☐ **LOGIC DESIGNERS** – To organize and perform logic designs of a high speed digital computer. (Degree in EE, Math or Physics with minimum 4 years' experience)

☐ **CIRCUIT DESIGN ENGINEERS (DISPLAY)** – To analyze equipment and circuit design requirements in data utilization and display subsystems. (Electrical Engineering degree with minimum 5 years' experience required)

☐ **SYSTEMS ANALYSTS** – To conduct system analysis programs and feasibility studies which lead to the conception and development of new systems, subsystems, and equipments of advanced design and function. (Advanced degree in EE, Math or Physics preferred with 3 years' previous experience)

☐ **TECHNICAL WRITERS** – To organize, write and publish progress and planning reports. (Engineering degree preferred with previous technical writing and editing experience in advanced electronics)

Dear Mr. Callender: Please send me an application form and additional information on the positions I have checked off above.

I am a graduate engineer with ________ *degree (s) and* ________ *years experience.*

NAME________________________________

ADDRESS______________________________

CITY______________________ZONE________

STATE________________________________

Mr. George B. Callender, Div. 24-ML

HEAVY MILITARY ELECTRONICS DEPT.

GENERAL ELECTRIC

Court Street, Syracuse, New York

See the GE HMED advertisement on page 240

Obtaining Capital

ment terms for small businesses, as defined by the act.

Private capital funds throughout the country are logical sources even though each may employ somewhat different risk standards. Some have limitations on individual dollar commitments, product line, industry and earnings record, etc. However, the number of private funds is such, that the basically sound management, a highly valued investment yardstick, should encounter little difficulty in arranging for his needs, not on confiscatory terms, but on a practical and equitable basis.

Presentation

These observations naturally lead to the heart of my subject. This is the method, or, as I prefer to define it—the manner or form of preparing the diagnostic presentation of your corporate anatomy to the fund investigator or analyst. Such a presentation can lead to a solid long-term banking association and a growth with distinction; or it can be followed by a future of financial uncertainty.

But, let me warn you, preoccupation with "putting your best foot forward" can be almost fatal. Your presentation must be balanced. It is not enough to define the good. You must also acknowledge the limitations of your company.

Obviously, each management instinctively prefers to minimize its chronic problems, assuming it is prepared to acknowledge that they exist. Yet, the alert fund investigator will, sooner or later, ferret these out and management explanations for these omissions then become doubly embarrassing.

The importance of proper presentation can best be illustrated by the high fatality rate disclosed by an executive of a major company. This was based on experience gained from preliminary screening of companies proposed for acquisition. He said, "We have applied this simple screening method to some 900 companies in the past six years, eliminating 8 out of 10 of them." He continued, "I have no doubt that we have missed some good companies in the process, but we believe that the benefits de-

Obtaining Capital

rived from such a procedure more than justifies the risk."

Although this official was referring principally to industrial companies for acquisition, a similar screening approach is often followed by risk capital funds in their examination of capital requests. Were this not done, it would be well-nigh impossible for the investigating staffs of these funds to function efficiently!

With this typical rejection ratio in mind, you can quickly appreciate the value of a well-prepared industrial presentation. Such a presentation is even more important for the electronic company. Even greater care must be applied to the scope, the detail, and simplicity of the data presented.

Consider for the moment, the seemingly simple matter of the language of the report. Then ponder and perhaps sympathize with the fund analyst. He must wade through, comprehend, and translate into a definitive accept or reject recommendation, the awe-inspiring nomenclature of such pristine sciences as: cryogenics, masers, cosmology, astronautics, ionic propulsion, doppler, forward scatter, multiplexing, and so on.

Your resume should include a primer dictionary of your company's products in lay language. This can be done and this enlightenment will be welcomed by the analyst, because it will greatly facilitate both his understanding and his initial evaluation of your company.

Financial Specialists

Now I should like to dwell briefly on other important items, about which information is too frequently lacking in many corporate representations. These deficiencies usually stem from the fact that many managements of small companies have heretofore confined their efforts to soliciting funds from their immediate circle of friends or local business men. Accordingly, they direct either their accountants or attorneys to prepare this material.

Although each is competent in his own sphere of influence—this is no assurance he is adequately familiar with the range of data on which the fund analyst must base his approval or rejection. I suggest these companies obtain the services of financial specialists who are objective, and who do not become emotionally involved in the client's financial or product problems.

Risk capital funds and the public underwriter have at least two common objectives—namely, substantial price appreciation for the company's shares and, in due time, participation in earnings through dividend payments.

But, whereas the underwriter passes the risk and ultimate reward or loss on to the public, the private fund assumes this risk directly. Consequently, it often probes even more deeply into those corporate activities which bear directly on management's abilities to attain the profit objectives, thereby reducing the risk factors proportionately.

Now to the specific points which, embodied in your capital request application, should enhance your prospects for obtaining capital, not only from private groups, but from public underwriters as well.

First, to the group picture of management which is, without question, the most critical aspect of any company appraisal. More than one negotiation for capital has fallen by the wayside because management maturity or cohesiveness was lacking. Management description should include a complete biography of all key officials, their engineering competence, and a schematic of the organization depth in terms of engineering, financial, administrative and sales personnel.

While seemingly morbid, some comment should also be included as to possible successors to the principals—having in mind death, or disagreement leading to a break-up of the engineering team—particularly, if the company's product mix is the brain child of one or two key officials.

Cash Flow

Of equal importance when soliciting funds, whether it be public or private, is some reasonable certainty that your capital request is adequate. Outline how you plan to profitably use these funds, and if monies are to be borrowed, approx-

Obtaining Capital

imately how and when you program repayment.

Generally, this information should appear in a section of your report titled "cash flow." The preparation of these data calls for the realistic forecasting by the combined talents of your financial, sales and engineering staffs. Oftentimes, it takes firm restraint on the sales staff to avoid overstimulation particularly when it is aware management is seeking working capital funds. So, a note of caution on the preparation of these figures is not out of place.

A thoughtfully projected cash flow is useful to management in many ways. As I previously noted, it permits management to predetermine whether its capital request is adequate to support the volume of business. It also affords an opportunity to peer into various associated operating cost sectors, including the flexible, general and administrative expenditures.

An untarnished and sober sales analysis, coupled with realistic accounting controls and estimates of costs in relation to an enlarged sales volume, will lessen the danger of management broadcasting a hasty SOS for more funds. Under such adverse and pressing circumstances, as you can imagine, new monies are most difficult to come by on favorable terms.

Another corporate area seen myopically by management is the merit of its produce line as compared with competition. It would be well for management to discuss frankly the performance characteristics of all known competitive items, as well as the comparative price structures, and comment where substantial differences exist.

Today, particularly in the field of electronics, considerable public attention is focused on R & D. I suggest, therefore, that managements do more than say—we spend x dollars on research—they should describe the engineering group in terms of number, engineering competence, and the manner by which programs are controlled in terms of allotted funds and time targets.

I believe the foregoing subjects, added to the usual topics, such as:

past sales and earnings history, patent structures, facilities owned or leased, distribution and ownership of existing stock, and debt, should provide the corporate principals with a document suitable for merchandising to either the underwriter or the private capital fund.

Enrollment Dip

(Continued from page 237)

graduates, 74 are continuing their studies in graduate schools.

Another thorny problem he mentioned was the increasing difficulty in attracting the best graduates to engineering teaching. Besides the obvious salary problem, he pointed out that large companies are operating their R & D labs with a university atmosphere so that competent professional people find not only high salaries in industry but "ivy on the walls" as well. Some companies he observed have staffed their labs almost exclusively with former university professors.

Conference to Define "Research Goals"

Fifteen scientific and engineering societies, including the American Society for Engineering Education and the Engineering College Research Council, are cooperating with Worcester Polytechnic Institute, Worcester, Mass., in a conference on "Research Goals" to be held Dec. 3 and 4 at the college.

The conference is being financed by a grant from the National Science Foundation. It will attempt to develop better means of communication of ideas in the research fields in order to stimulate young research scientists and engineers to undertake projects which have greater promise of significant discovery.

There is a growing concern that new centers of research emerge very slowly both in the discovery of frontier scientific knowledge and also in the application of new science to the development of new technologies. The conference is being held in the belief that there is a serious need of exploring ways of bringing to talented young people the thinking of those who are working in advanced research and who have the larger perspective of research possibilities. The conference will prepare specific recommendations for ways of improving the communications of these ideas.

Engineering Education

(*Continued from page* 237)

The funds will be used as follows: $3,500,000 to endow seven professorships in new fields of engineering; $3,000,000 to evolve new courses to couple the basic sciences with the newly emerging fields of engineering, and to introduce students to the "hard-headed" purposefulness of engineering $1,500,000 for the development of new laboratories; $1,000,000 for post-doctoral teaching internships and research fellowships; $150,000 for fellowships and loans for graduate students working for the doctor's degree and who expect to become professors; and $125,000 for faculty development.

Possible "themes" for the new curricula: Materials, Propulsion (new forms both for earth vehicles and space vehicles, Energy Processing (solar, nuclear and other forms), Information Processing, and Environment Engineering.

Fellowship Applications Must be in by Jan. 1, '60

Applications are being accepted for National Science Foundation Graduate Fellowship awards for advanced study in the mathematical, physical, medical, biological and engineering sciences, including anthropology, psychology (excluding clinical psychology), and certain social sciences.

Fellows will be selected on the basis of ability as attested by letters of recommendation, academic records, and other evidences of attainment. Applicants are required to take the Graduate Record Examination. Qualifications will be evaluated by panels operating under the National Academy of Sciences — National Research Council. Final selection will be made by the National Science Foundation.

Application material may be obtained from the Fellowship Office, National Academy of Sciences — National Research Council, 2101 Constitution Ave., N.W., Washington 25, D. C. Closing date is Jan. 1, 1960. Selections will be announced March 15, 1960.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 201.

Industry News

David P. Higgins has been appointed Special Assistant to the Vice President and General Manager of Litton Industries' Maryland Div.

Louis P. Clark is now Manager of the Florida Div., Radiation, Inc. He is also Vice President of the company.

Herman Fialkov, President of the General Transistor Corp., Jamaica, N. Y., has been elected a Director of the Long Island Electronic Manufacturers' Council.

Robert L. Westrum has been appointed Manager for original equipment sales of D. W. Onan & Sons, Inc.

H. Myrl Stearns, President of Varian Associates, and has been elected a Fellow of the American Association for the Advancement of Science.

Richard T. Barrett has been appointed Manager of Advanced Systems Sales for the Lockheed Electronics and Avionics Div. (LEAD).

R. T. Barrett

W. S. Sadler

William S. Sadler is now President of Minnesota Radio and Television (Miratel, Inc.).

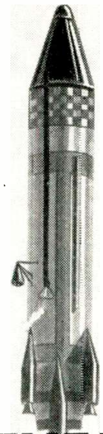
C. Robert Stone has been named Chief Production Engineer at Potter and Brumfield Div., American Machine & Foundry Co.

The election of **Cole H. Pilcher** as Vice President for Industrial Relations of ACF Industries, Inc., has been announced.

The Western Electronic Manufacturers Assoc. has added **Lawrence Priddy, Jr.,** to its Executive Staff.

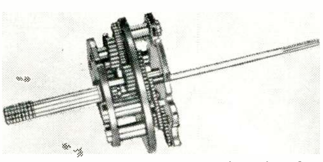
Robert T. De Vore has been appointed as EIA Public Relations Director.

Alex Lewyt has been elected to the Board of Directors of the Budd Co.



ACHIEVEMENT IN PRECISION

Precision in design and manufacture is not sufficient to put your product up in the PRECISION orbit. Precision in thought resulting in precision planning and organization is also required. This faculty which underlies our creative engineering, our craftsmanship and our manufacturing skill is our greatest resource. To this we owe our leadership in the design and manufacture of precision electrical, electro-mechanical and electronic products for the modern, ever-growing fields of instrumentation and automation.



One of our specialties is the design and manufacture of custom-made fine pitch precision gears up to AGMA Precision #3, 1/8" to 5" O.D., 180 to 16 D.P. Boehme gears form an essential part of the "classified" equipment vital to the Nation's Commerce, Industry and Defense.

Your inquiries are invited. There is no obligation. Write for further details, today!

H. O. Boehme, Inc.

Contractors, Designers, Manufacturers of Precision Electrical, Electro-Mechanical and Electronic Equipment since 1917

915 Broadway
New York 10, N. Y.

HOB

Circle 144 on Inquiry Card

Industry News

Frank P. DeLuca, Jr., has been appointed Executive Vice President of Acoustica Associates, Inc. He was formerly Vice President and General Manager of the Co's Western Div.

Wells R. Chapin has been appointed to the newly-created post of Manager of Marketing for Dage Television Div., Thompson Ramo Wooldridge Inc.

Bernard M. Goldsmith has been appointed President of Nytronics, Inc. He was formerly President of Essex Electronics.

B. M. Goldsmith

F. L. Marx

Frank Louis Marx has been elected a Director of Foto-Video Laboratories, Inc. He is Vice President in Charge of Engineering, American Broadcasting Co.

Tom Brown, former Vice-President of Oxford Electric Corp. is now Sales Manager for the Magnetic Tape Div., Sarkes Tarzian, Inc.

Two new executive positions at Sperry Gyroscope Co. have been announced. **Arthur A. Hauser, Jr.**, is now Director of Technical Planning and **John J. Rutherford** is Director of Long-Range Planning.

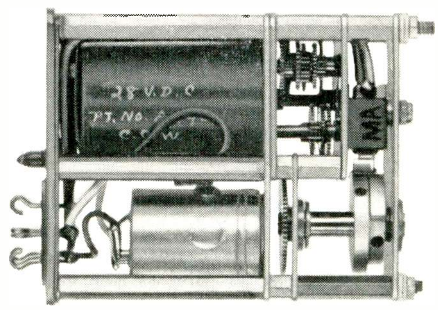
Major General Louis Rumaggi (Ret.), U. S. Army Corps of Engineers, has joined Texas Instruments Incorporated as Manager, Central Services Section, in the Central Marketing Div.

George A. Strichman is now President of Kellogg Switchboard and Supply Co.

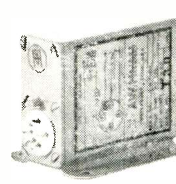
Herbert I. Chambers is now Associate Director of the DataTape Div., Consolidated Electrodynamics Corp.

Berne N. Fisher, General Manager of Brubaker Electronics Div. Telecomputing Corp. has been advanced to Vice President of the parent corporation.

IT'S ABOUT TIME



Whether an interval is a month or a microsecond, you can measure it, divide it, record it, or use it for control with a custom-designed or standard timer from The A. W. Haydon Co. Every type, every size, every class... timing motors, time delay relays, interval timers, repeat cycle timers... you name it, we make it. If you ever have a specific timing problem, the least you can do for yourself is get our literature. Bulletin RC 301 (on the 4400 Series repeat cycle timer) is yours for the asking. ■ The 4400 Series sub-miniature repeat cycle timer weighs 6½ ounces. Cycling times: 5 secs to 90 minutes. Up to 8 poles double throw. Hermetically sealed.



THE AW HAYDON COMPANY
219 North Elm Street, Waterbury 20, Connecticut

Circle 145 on Inquiry Card

Industry News

Philip F. Dietz has been appointed Manager of the Westinghouse Electric Co.'s Rayescent Lamp Dept.

New Engineering Manager of Conrac, Ind., is Charles A. Nichols. He was formerly Vice-President in charge of Engineering at Hoffman Electronic Corp.

International Business Machines Corp. has elected **Dr. James R. Killian, Jr.**, as a Director. Dr. Killian is Chairman of the Corporation of the Massachusetts Institute of Technology and a member and former Chairman of President Eisenhower's Science Advisory Committee.

Andrew J. Unetic is now Vice President and Instrument Division General Manager of Bourns, Inc.


A. J. Unetic


L. W. Esterling

Louis W. Esterling has been named to the newly created position of Marketing Director and Head of Defense Contracts Administration at Rixon Electronics, Inc.

John W. Murphy has been appointed Manager of Operations, Instruments Div. of Daystrom, Inc.

Appointments to two top managerial posts in its Government Equipment Div. at Raytheon Co. have been announced. Named were **Glenn R. Lord** as Manager of the division and **Fritz A. Gross** as Assistant Manager.

Thomas E. Holland is now Director of the recently formed Research & Development Div. and Vice President of Beckman & Whitley. He had been Director of Research in the George Washington University Research Laboratory.

David C. Cleckner, Staff Assistant to the Chief Engineer of Melpar, Inc., a subsidiary of Westinghouse Air Brake Co. has been elected Chairman of the Washington Section of the IRE's Professional Group of Engineering Management.

Industry News

C. W. Paulson, Manager, Room Air-Conditioner Dept., Westinghouse Electric Corp., has been elected Chairman of the Room Air-Conditioner Section of the National Electrical Manufacturers Assoc.

New officers of the Powder Metallurgy Parts Manufacturers Assoc. are: **Carl J. Demrick**, President of Amblex Div., Chrysler Corp., President; **Smith Bolton**, Divisional President and General Manager of the U. S. Graphite Co., Vice President; **G. G. Fellows**, President of American Powdered Metals, Inc., is Treasurer.

C. Robert McBrier has been re-elected Chairman of the Electronics Committee of the Retail Research Institute of the National Retail Merchants Assoc.

Dunlap and Assoc., Inc., announces the election of 4 members of its staff, **Dr. Roland C. Casperson, Gershon Cooper, Dr. Jerome H. Ely,** and **Joseph T. Fucigna,** as Assistant Vice Presidents.

The Western Association of Circuit Manufacturers has elected these new officers: President, **S. L. Glaspell,** Graphik Circuits; Vice President, **N. W. Vallance,** Electro Etch; Program Chairman, **Vona Ott,** Circuitronics; Secretary, **Basil Harris,** Circuitronics; Treasurer, **R. Andrews,** E. C. M. Electronics.

Raymond C. Geiger has been appointed Manager of Manufacturing control at the Maryland Div. of Litton Industries.

Appointment of **Joseph C. Duke** to the newly created position of Executive Vice President for Sales Administration and Public Relations has been announced by Minnesota Mining & Mfg. Co.

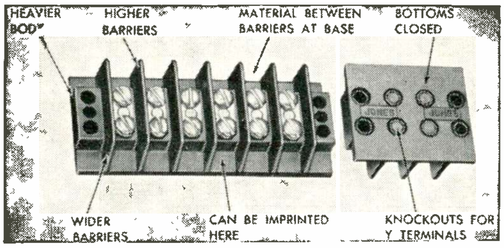
Wolfgang G. Prenosil has been appointed to the new post of Director, Transistor Marketing, for Hoffman Electronics Corp.'s Semiconductor Div.

Appointment of **Richard C. Palmer,** as Vice President of the Stromberg-Carlson Div., General Dynamics Corp., has been announced.

Wilfrid G. Matheson, Supervisor of Incandescent Lamp Research for Sylvania Lighting Products, a division of Sylvania Electric Products, Inc., has been named President of the American Vacuum Society.

Henry Lehne has been elected Sr. Vice President of Sylvania Electric Products, Inc.

AT LAST—The IDEAL BARRIER TERMINAL STRIP



JONES 500 SERIES

LONGER—STURDIER

Wider and higher barriers for increased creepage distances. Closed bottoms for complete insulation. Material between barriers at the base adds to the strength and maintains the same creepage distance between contact to contact and contact to ground. Can be imprinted here. No insulating or marker strip required. Three series—540, 541 and 542 having the same terminal spacing as our 140, 141 and 142 series.

Complete listing in the new Jones No. 22 catalog. Write for your copy today.

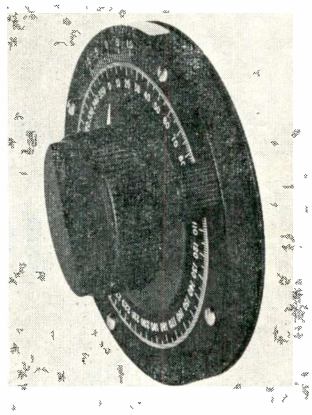
Jones

HOWARD B. JONES DIVISION
CINCH MANUFACTURING COMPANY
CHICAGO 24, ILLINOIS
DIVISION OF UNITED-CARR FASTENER CORP.

Circle 301 on Inquiry Card

New Design

Dial Assembly for Synchros and Pots



This attractive, panel-mounted positioning device will accept synchros and pots without any additional fixturing.

Specifications: Readability, 0.1° from 0° through 360°—Accuracy, 0.1°—Range, 360° continuous rotation—O.D., 5 in.

Price: $85 each for standard sizes.

Delivery: Immediate, from stock.

A complete Technical Bulletin will be mailed to you upon request.

Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J., Hubbard 7-3508, TWX-HKK 952U.

Circle 302 on Inquiry Card

WRITE FOR

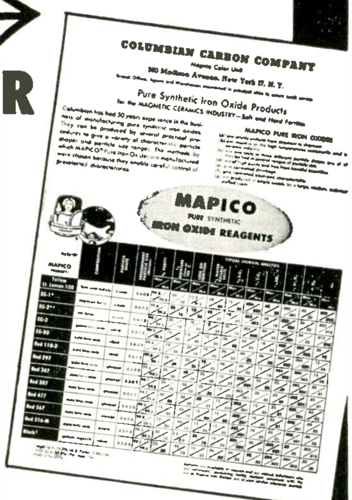
this useful informative chart on

MAPICO

pure synthetic

IRON OXIDES

for ferrites



This handy card gives you details on composition, particle shape and chemical analyses of Mapico's wide range of pure synthetic iron oxides. Unequalled for uniformity . . . Mapico oxides are available in three different particle shapes, each with several ranges of particle size . . . provide controlled electronic characteristics and shrinkage. Ask for this free chart.

Mapico® Iron Oxides Unit

Columbian Carbon Company
380 Madison Avenue, New York 17, N. Y.

Circle 303 on Inquiry Card

Kodak
TRADE MARK

Q: What is a Kodak Ektron Detector?

A: It is a semi-conductive resistor. The photosensitive area can be laid down in any pattern. Response extends to 3.5 microns in the infrared. Unaffected by vibration; high signal-to-noise ratio.

Q: What can it be used for?

A: For such applications as an infrared sensor in weapons systems, and in instrumentation for process control, analysis, and safety.

Q: How can I get the facts about spectral response, types, availabilities, and the like?

A: By writing for a new brochure called "Kodak Ektron Detectors."

Write to:

Apparatus and Optical Division
EASTMAN KODAK COMPANY, Rochester 4, N. Y.

Circle 304 on Inquiry Card

Electronic Industries'

ANNUAL INDEX—1959

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.

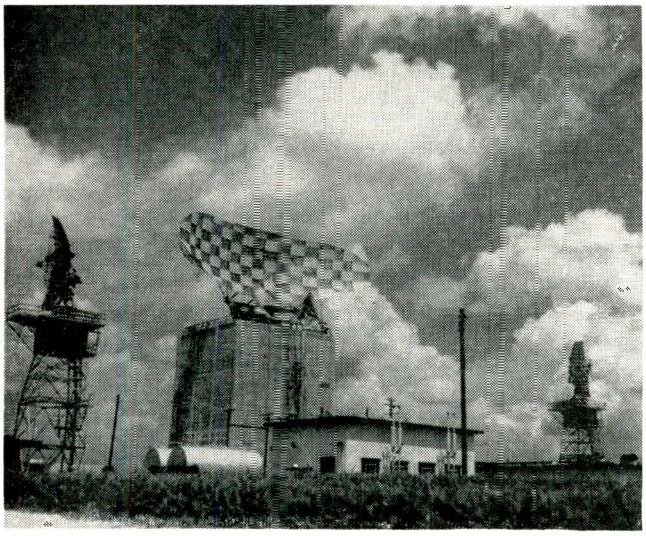
(*Continued on page 260*)

ANNUAL INDEX—1959

AUTHORS INDEX

(*Continued on page 262*)

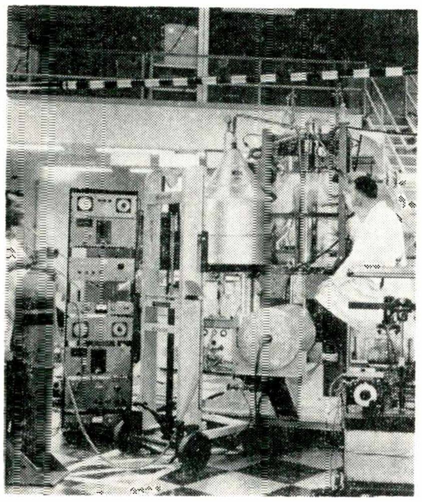
SEARCH RADAR



The Air Force's AN/FPS-35 shown at Thomasville Aircraft Control & Warning Site, Alabama. Sperry Gyroscope was system manager. Antenna weighs nearly 70 tons. Tower is 85 ft. high and 60 ft. wide.

EUROPEANS consider U. S. electronic business machines outstanding, but in the overall view of American products there is a good deal of criticism of styling and poorly finished products. This was turned up by a recent study by the Opinion Research Corp. of the European Economic Community (ECC). The survey, which covered 735 French and German nationals, also showed that American firms in Europe are being praised for their employment practices and management approaches, but criticized for a "flashy display of luxury" and "wasteful practices."

BOMBARDING INDIUM



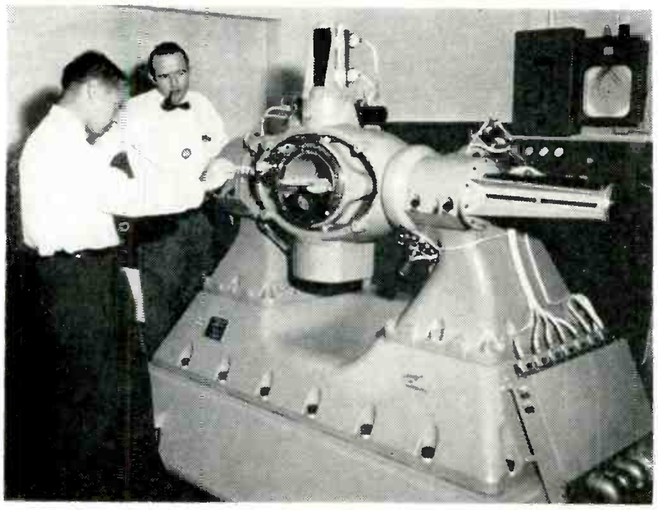
Hofman 4-liter liquid research dewar is being filled with nitrogen. Dewar features a copper window through which a neutron beam from a reactor bombards indium sample. Objective is to investigate how polarized neutrons combine with polarized nuclei.

NEXT INDUSTRY to go in heavily for electronic control will be the railroads. From an engineering standpoint completely automatic train operation is possible at the present state of the art. In addition to automatically controlling the movement of rolling pieces, the equipment would also maintain continuous records of train movements.

RADARSCOPE continues on page 263)

ANNUAL INDEX—1959

GROUND FLYER



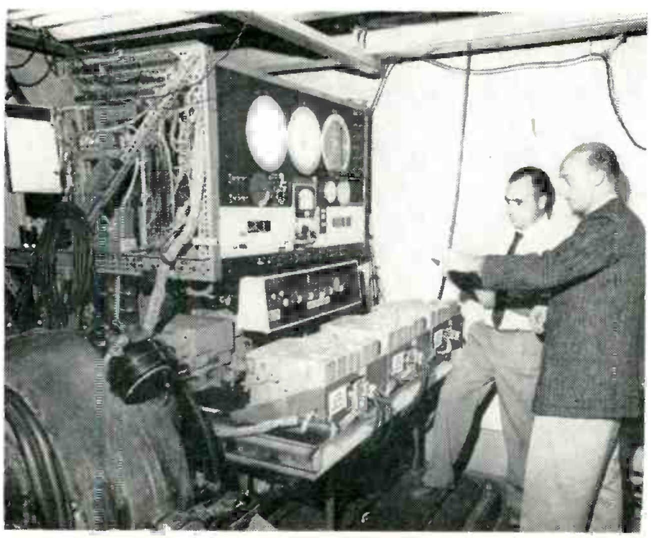
Convair engineers examine features of a new Bendix flight simulator table which has successfully tested B-58 equipment.

"INTELLECTRONICS," the science of extending man's intellect through electronics, will become the nation's greatest industry within a decade, says Dr. Simon Ramo. "Space," he said, "has awakened us to a new appreciation of the impact of science and technology on our way of life. But, electronics, and intellectronics in particular, will be more influential than space exploration for the foreseeable future. All the physical operations of our civilization—production, transportation, communication, banking, marketing—will be done with a much better match between synthetic brain devices and human brains."

"MICRO-MICRO" DIODE, introduced by Pacific Semiconductors Inc., is a significant step towards hand-sized computers and pocket-sized instrumentation system. The units are so small that 20,400,000 will fit into a single cubic foot of space. Size reduction is accomplished by a new molecular bonding development.

RELIABILITY TESTS

AiResearch engineers read panel showing results of air data reliability test which were recorded on film. Three of six computers tested are seen on bench. Units operated continuously for 1000 hrs. each.



Give your products
MORE RELIABILITY *and*
BETTER PERFORMANCE *with*

FREED QUALITY

Ruggedized,
MIL STANDARD
POWER & FILAMENT TRANSFORMERS
Primary 105/115/125 V 50-60~

Cat. No.	Appl.	MIL Std.	MIL Type
MGP 1	Plate & Fil.	90026	TF4RX03HA001
MGP 2	Plate & Fil.	90027	TF4RX03JB002
MGP 3	Plate & Fil.	90028	TF4RX03KB006
MGP 4	Plate & Fil.	90029	TF4RX03LB003
MGP 5	Plate & Fil.	90030	TF4RX03MB004
MGP 6	Plate	90031	TF4RX02KB001
MGP 7	Plate	90032	TF4RX02LB002
MGP 8	Plate	90036	TF4RX02NB003
MGF 1	Filament	90016	TF4RX01EB002
MGF 2	Filament	90017	TF4RX01GB003
MGF 3	Filament	90018	TF4RX01FB004
MGF 4	Filament	90019	TF4RX01HB005
MGF 5	Filament	90020	TF4RX01FB006
MGF 6	Filament	90021	TF4RX01GB007
MGF 7	Filament	90022	TF4RX01JB008
MGF 8	Filament	90023	TF4RX01KB009
MGF 9	Filament	90024	TF4RX01JB012
MGF 10	Filament	90025	TF4RX01KB013

Ruggedized,
MIL STANDARD
AUDIO TRANSFORMERS

Cat. No.	Imped. level—ohms	Appl.	MIL Std.	MIL Type
MGA 1	Pri. 10,000 C.T. Sec. 90,000 Split & C.T.	Interstage	90000	TF4RX15AJ001
MGA 2	Pri. 600 Split Sec. 4, 8, 16	Matching	90001	TF4RX16AJ002
MGA 3	Pri. 600 Split Sec. 135,000 C.T.	Input	90002	TF4RX10AJ001
MGA 4	Pri. 600 Split Sec. 600 Split	Matching	90003	TF4RX16AJ001
MGA 5	Pri. 7,600 Tap @ 4,800 Sec. 600 Split	Output	90004	TF4RX13AJ001
MGA 6	Pri. 7,600 Tap @ 4,800 Sec. 4, 8, 16	Output	90005	TF4RX13AJ002
MGA 7	Pri. 15,000 C.T. Sec. 600 Split	Output	90006	TF4RX13AJ003
MGA 8	Pri. 24,000 C.T. Sec. 600 Split	Output	90007	TF4RX13AJ004
MGA 9	Pri. 60,000 C.T. Sec. 600 Split	Output	90008	TF4RX13AJ005

MIL Transformers are available from stock.

Write for further information on these units or special designs.

Send for NEW 48 page transformer catalog.

Also ask for complete laboratory test instrument catalog.

FREED TRANSFORMER CO., INC.
1726 Weirfield St., Brooklyn (Ridgewood) 27, N. Y.
Circle 309 on Inquiry Card

Timer Will Shut-Off Satellite's Signal

A one-billionth horsepower miniature timing mechanism will automatically turn off Explorer VII's solar-powered radio transmitter after the useful data has been accumulated.

The self-contained electronic timer was developed by Bulova Watch Co. to weigh less than a half-pound and be smaller than a 2-inch cube. It was ordered by the Army on a "crash" basis.

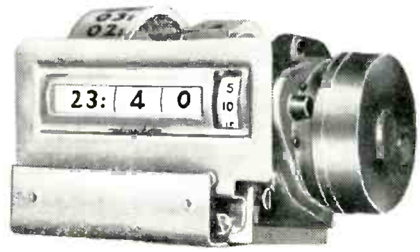
The satellite, launched by an Army Juno II rocket, was the first man-made-moon to be equipped with an automatic timekeeper. The radio equipment needed to receive a turning-off signal from earth would have been far too bulky and heavy.

Without something to turn off the solar-powered batteries that keep the transmitter operating, the satellite could send signals back to earth long after their scientific usefulness had been accumulated. Eventually, scientists figure, the outer-space air waves could be saturated with out-of-date satellite signals.

A NEW CONCEPT IN TIME©

DIGITAL CLOCK MOVEMENTS

AUTOMATIC TIME CALCULATORS



Available in:

- 12 HOUR SYSTEMS
- 24 HOUR SYSTEMS
- 30 MINUTE TIMERS
- ELAPSED TIMERS
- IMPULSE TIMERS
- COUNT DOWN TIMERS

Available in All Frequencies and Voltages

Height 3", Width 4½", Depth 2½", Wt. 1¾ lbs.

Write or Call FRemont 1-4200 for Catalog on the Complete Line Showing Specifications

PENNWOOD NUMECHRON CO.
7249 FRANKSTOWN AVENUE
PITTSBURGH 8, PENNSYLVANIA

Circle 310 on Inquiry Card

PUBLI SERVICE

IN PARIS
FROM FEBRUARY
19th TO 23rd
1960

the 3rd **international exhibition of electronic components**

The greatest world gathering in the field of electronics.

Recognized Travel Agency :
Cook's International Sleeping-Car Agency

FÉDÉRATION NATIONALE
DES INDUSTRIES ÉLECTRONIQUES FRANÇAISES
(F.N.I.E.) 23, rue de Lübeck - PARIS 16e - Tél. : PAS. 01-16

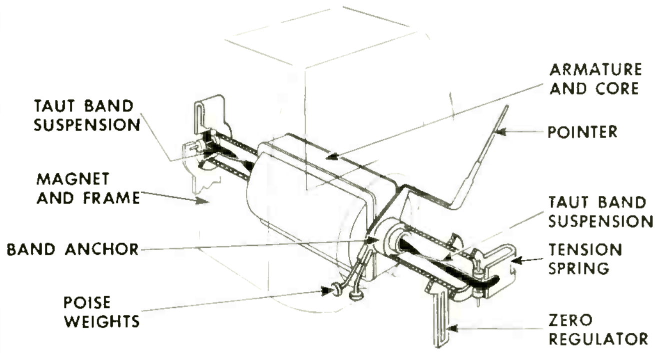
Circle 311 on Inquiry Card

ELECTRONIC INDUSTRIES Advertisers — December 1959

This index is published as a convenience. No liability is assumed for errors or omissions.

Taut-Band Meter

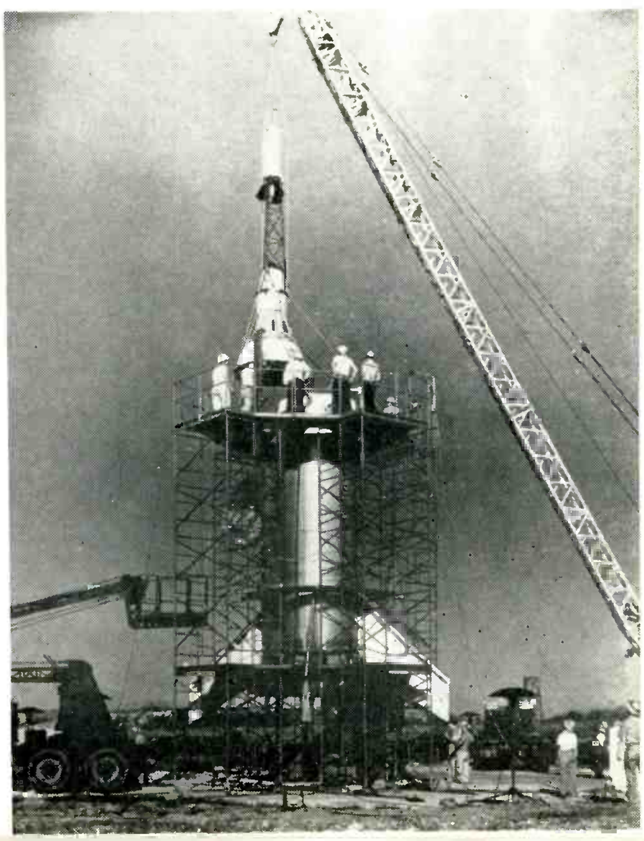
THE taut-strip principle, a variation of the galvanometer suspension, is being used by Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio, in a series of meters suitable for class 0.5 instrument applications. The suspension is made practical through the development of a new alloy used as thin metal bands to support the movement, carry current, and provide the restoring torque.



The movement eliminates the bearing-pivot-hairspring element. Ranges are extended to such sensitivities as ½ microampere for 100 angular degrees pointer deflection and units having power consumptions on the order of 0.00000001 watts. Hickok engineers have applied the technique to instruments of the conventional 100° panel type DC meters, 250° long scale meters, laboratory standards, AC iron vane type meters, and AC dynamometer type meters. Units have been subjected to the vibration, mechanical and high impact tests of MIL-M-10304A. Ambient temperature errors are approximately one-half that of pivot-type assemblies.

"LITTLE JOE"

"Little Joe" test capsule is in process of installation at NASA launching site, Wallops Island, Va. Capsule will gather information for manned space flights.



George at the Forge

The day the mobile radar was delivered to Washington at Valley Forge, it was so cold a man's shadow froze to the ground. Nevertheless, the Father of his Country managed to work up a good head of steam when he saw the unit.

*"Idiots!" he stormed. "Why do they send me radar when we need food and shelter and clothing? What good is it? Does it have Bomac tubes?"**

"No sir," his orderly shivered. "It doesn't seem to have any tubes at all. But it might make a nice warm fire."

"I was thinking the same," Washington said. And, without another word, he went and got a little hatchet and chopped and chopped. The wind blew and the chips flew. Soon, the installation was reduced to kindling.

"That's more like it," the General said when he was done. "Now, if someone will hand me a match . . ."

But he never finished the sentence. The ice on which he was standing suddenly gave way, and he disappeared into the frigid water.

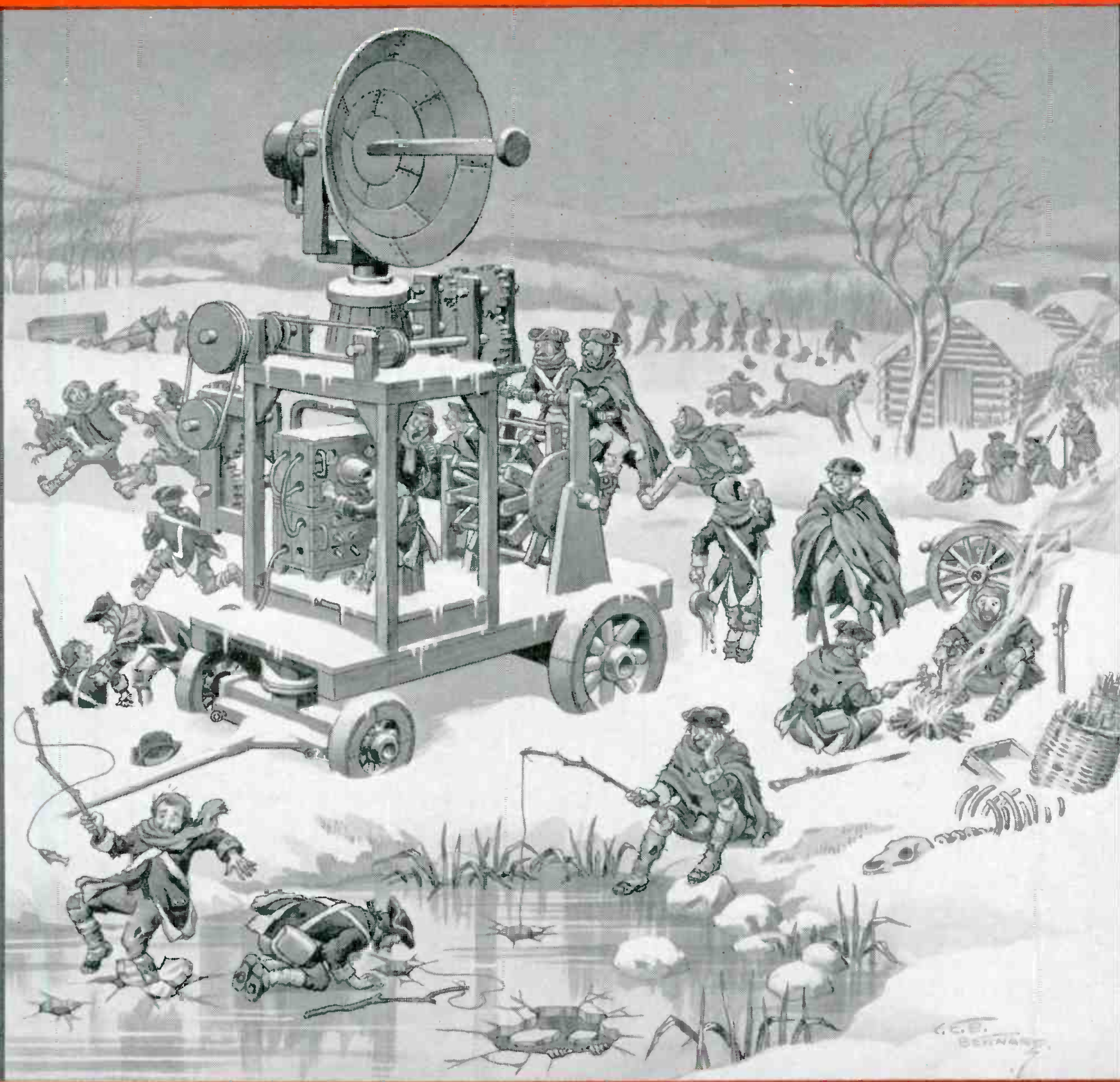
"General, general are you all right?" the orderly asked as he fished him out.

"I'm afraid so," Washington said. "But you'd better put a sign here to warn the others."

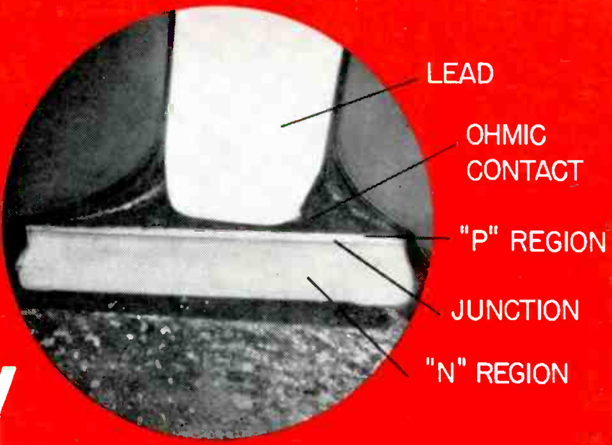
So, that was why the famous sign was put up — the sign you can see today when you visit Valley Forge. You know the one.

It reads "George Washington slipped here."

No. 17 of a series . . . BOMAC LOOKS AT RADAR THROUGH THE AGES



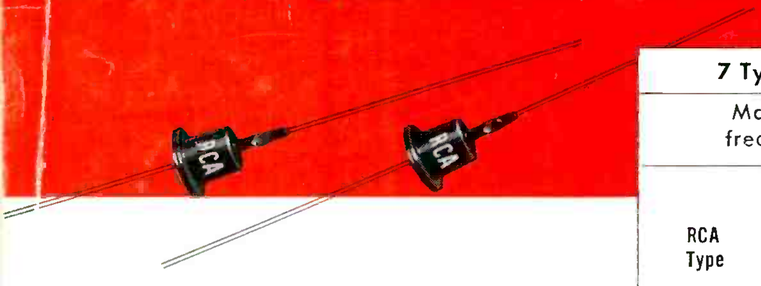
DIFFUSED-JUNCTION UNIFORMITY



This photomicrograph shows the exceptional junction flatness across the entire pellet that is typical of silicon rectifiers produced by the RCA diffusion process. This junction flatness is achieved by slow-rate diffusion, which permits precise control of diffusion depth and junction gradient. Results—uniform current density throughout the silicon, with consequent freedom from "hot spots"; improved electrical characteristics in both forward and reverse directions; and, exceptional uniformity from unit to unit.

assures reliability, long life of

RCA SILICON RECTIFIERS



Advanced manufacturing techniques and extensive quality-control procedures are your assurance of reliability and long life when you specify RCA Silicon Rectifiers. *Every RCA Silicon Rectifier* you receive has been subjected to a 24-hour seal test under pressures in excess of 5 atmospheres, and has been stabilized by repeated thermal cycling over the full operating-temperature range before final electrical testing. *Every RCA Silicon Rectifier* you receive has also been subjected to the following extra tests to insure dependable performance under extreme conditions: reverse (leakage) current at 25°C; forward characteristics at 25°C; high-temperature dynamic reverse (leakage) current test at full load current and maximum rated voltage. In addition, samples from every production lot of RCA Silicon Rectifiers are subjected to life tests under maximum rated conditions of temperature, current, and voltage to provide further assurance of RCA's high standards of quality.

7 Types for INDUSTRIAL and MILITARY Power Supplies

Maximum Ratings, Absolute-Maximum Values: For supply frequency of 60 cycles and with resistive or inductive load

RCA Type	Peak Inverse Volts	DC Forward Ma at Ambient Temperature of 50°C	CHARACTERISTICS at Ambient Temperature of 25°C: Maximum Reverse Current (DC) at maximum peak inverse voltage (μa)	CHARACTERISTICS at Ambient Temperature of 150°C: Maximum Reverse Current (averaged over one complete cycle) at maximum peak inverse voltage (μa)
1N536	50	750	5	400
1N537	100	750	5	400
1N538	200	750	5	300
1N539	300	750	5	300
1N540	400	750	5	300
1N1095	500	750	5	300
1N547	600	750	5	350
6 Types for MAGNETIC-AMPLIFIER Applications requiring exceptionally low leakage current				
1N440-B	100	750	0.3	100
1N441-B	200	750	0.75	100
1N442-B	300	750	1.0	200
1N443-B	400	750	1.5	200
1N444-B	500	650	1.75	200
1N445-B	600	650	2.0	200

Contact the RCA Field Office nearest you for information on types for your specific applications. For technical data see the new RCA HB-10 SEMICONDUCTOR PRODUCTS HANDBOOK, or write RCA Commercial Engineering, Section L50NN, Somerville, N. J.

EAST:
744 Broad Street
Newark 2, New Jersey
HUmboldt 5-3900

EAST CENTRAL:
714 New Center Bldg.
Detroit 2, Mich.
TRinity 5-5600

WEST:
6355 E. Washington Blvd.
Los Angeles 22, Calif.
RAymond 3-8361

NORTHEAST:
64 "A" Street
Needham Heights 94, Mass.
HIllcrest 4-7200

GOVERNMENT:
224 N. Wilkinson Street
Dayton 2, Ohio
BAldwin 6-2366

1625 "K" Street, N. W.
Washington 6, D. C.
District 7-1260

CENTRAL: Suite 1154, Merchandise Mart Plaza, Chicago 54, Illinois. WHitehall 4-2900

ALSO AVAILABLE AT YOUR LOCAL RCA SEMICONDUCTOR DISTRIBUTOR

RADIO CORPORATION OF AMERICA

SEMICONDUCTOR AND MATERIALS DIVISION • SOMERVILLE, N. J.