ELECTRONIC INDUSTRIES

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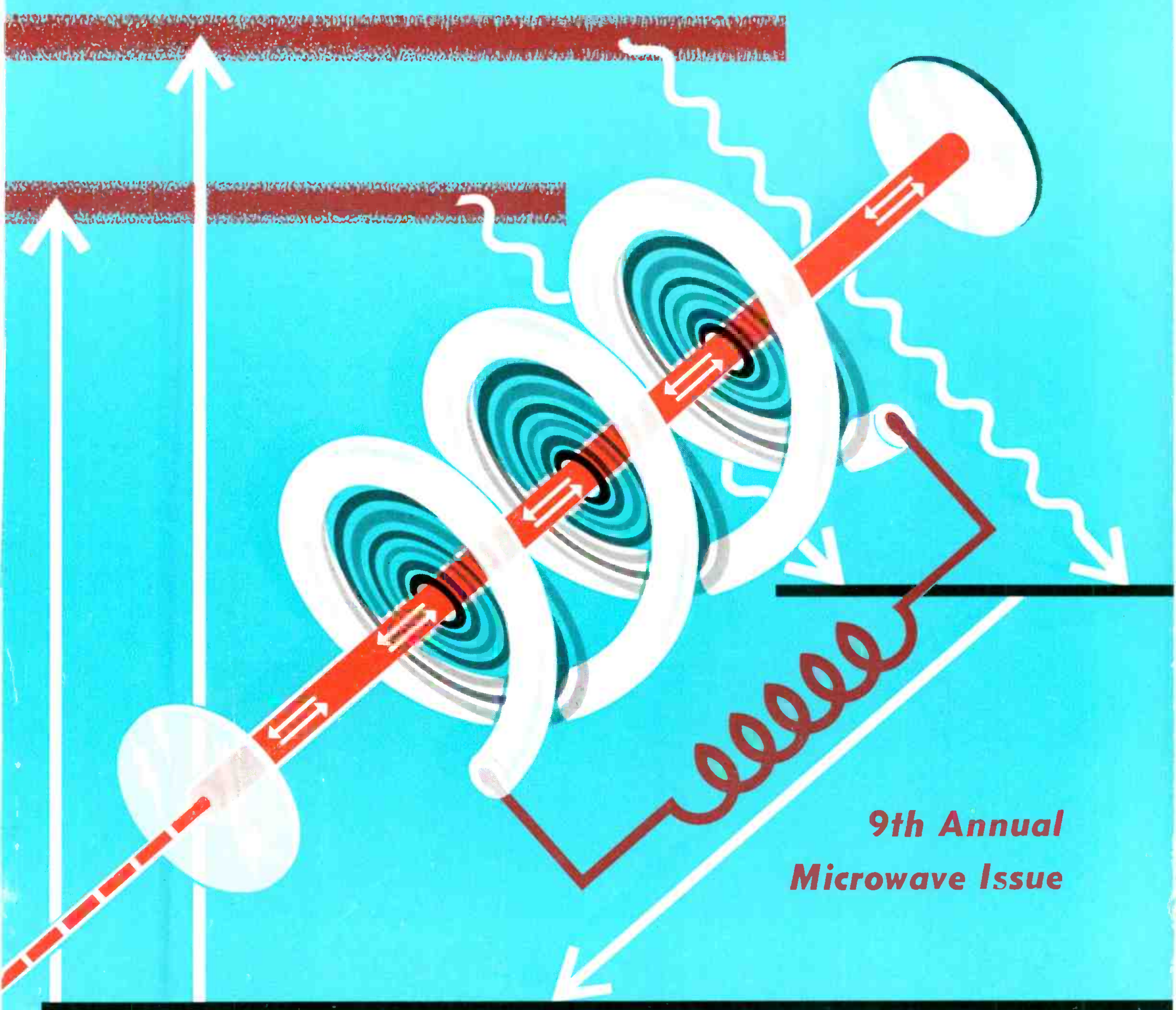

9th Annual Microwave Issue

- 1961 Survey of Microwave Electron Devices
- TWT's for Modern Radar
- Microwaves—Past, Present and Future . . .

November
1961

ELECTRONIC INDUSTRIES

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

Microwaves in 1962!

HERE it is! The Ninth Annual Microwave Issue of Electronic Industries.

On our cover we have tried to capture the latest in the way of microwave developments. It shows an optical maser, one using ruby to be specific. The background depicts the energy level diagram of the ruby.

In our lead story, Dr. Tomiyasu treats briefly on the history of the industry, dwells at length on the most recent developments, and rationalizes on present day speculation. All in all, technologically, he considers microwave as a most fertile field. Dr. Tomiyasu's article "Microwaves, Past, Present, and Future" starts on page 90.

But, although the field is so promising in this aspect, there are some clouds. These are on the business horizon. It is generally conceded that none of the big manufacturers is getting a reasonable return on his investment in the commercial microwave field. This is due to bad pricing policies rather than to special features which customers may require.

Commercial customers are somewhat like government customers—they place too much emphasis on the low bid and too little on reliability and overall cost including maintenance.

Even the largest suppliers of commercial microwave systems are making only a marginal profit when engineering is considered. One of the big reasons for this lack of profit is that each system is treated as something new. Apparently very little thought is given to standardizing the components and the systems. In other words, it is a job shop operation instead of a production line.

In a recent report, "Microwave Communications: Commercial Possibilities in the 60's," members of our industry were warned not to expect too much from private microwave communications over the next two or three years.

This report was prepared and published by eight graduates of the Harvard Business School under the name of Micom Associates, P. O. Box 1306, Grand Central Sta., New York 17, N. Y.

In support of what we have just stated, the report goes on to state that the commercial end of the microwave business has been characterized by bitter competition. Profits, the report feels, among the systems manufacturers, selling equipment to the private market are negligible because there are too many in too small a market.

The report suggests that the manufacturers can help to ensure survival by a combination of right-of-way, military, and common carrier business to support their research and development programs.

Another interesting tid-bit from this report is that a recent study shows that there is little immediate demand among businessmen for high-speed data transmission facilities.

To round out this issue, and to help a little in the standardization of microwave products, we present our *verified* directory of manufacturers and their specific products in this field. Also, considerably expanded, and equally important—up-dated, is our Summary of Microwave Electron Devices. This chart, beginning on page 139, gives the complete specifications of power generating or amplifying devices in the region above 500 MC.

R. G. S.

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ELECTRONIC INDUSTRIES

Vol. 20, No. 11 **November, 1961**

COVER: In this month's foreground we portray the optical maser. As the helical flash lamp "pumps" (concentric rings) the chrominum atoms of the ruby rod to higher energy levels, the wave grows. Mirrors reflect the wave (arrows in rod) and it continues to grow. The coherent output beam is emitted through a partially silvered mirror. In the background is the energy level diagram of the ruby. The ruby's chromium atoms are pumped to one of two energy levels; fall to a metastable level when they give up some of their energy to the crystal lattice; and when stimulated by other chromium atom photons, emit photons of a characteristic wavelength and fall to the ground state.

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BPA NBP

Highlights

of this issue

Microwaves—Past, Present, and Future page 90

Being a technique, microwaves are useful in many fields of technology, such as radio, physics, and optics. The areas which deserve the most attention, because of growth potential, are high power microwaves and optical masers.

Radar Antenna Test Load page 94

Designed for use in final radar system tests, this space type load presents a constant magnitude, variable phase, reflection to the transmitter. It is useful in studying the effects of transmitter-to-antenna mismatch caused by abnormal weather, such as icing conditions.

Modern TWT Focusing Methods page 96

The heart of many microwave systems is the traveling-wave tube. Integrally packaged TWT's used today employ three focusing techniques. The features of each are presented here, in a concise manner, as an aid to proper selection.

High Power Microwave Component Testing page 100

The recent experiments of Frankford Arsenal have shown that high power RF Testing of microwave components is necessary to ensure that performance is accurately assessed.

Thermal Drift in Microwave Power Meters page 102

Although bolometer type microwave power meters have been around for 15 years, not till recently have compensated devices been designed to overcome their thermal drift sensitivity. Here's how to achieve a realistic design goal of 100 times less detector mount drift than previously available.

Eliminating Distortion in the TWT page 104

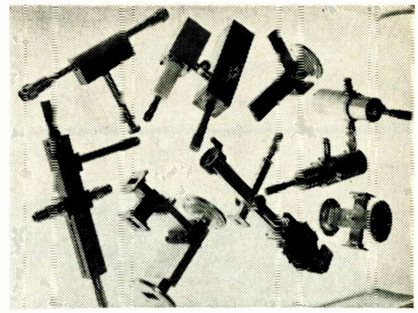
Strange that with an art advanced to tubes with octave bandwidths, megawatts of peak power, and 2 db noise figures, we should apparently step backwards to a 10% bandwidth and 5 kw peak power. But the reason is simple—the new systems can tolerate very little distortion. Here's one approach!

Equating 'Noise-Temperature' with 'Noise Figures' page 108

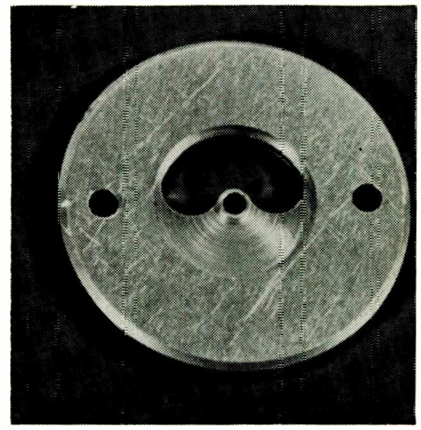
With the increased use of masers and parametric amplifiers, the term "effective noise temperature" is replacing "noise figure." Since this causes two sensitivity figures, there is much confusion—mainly in converting equations with one term to the other. Here's how to use each —and how the relationship is derived.

High Power TWT's page 112

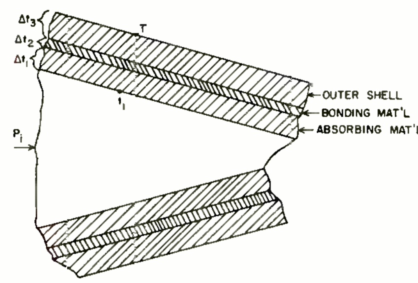
In the past, traveling-wave tubes were available for either high power or wide-band applications. Now, with new techniques described here, both desirable features are available in one package.



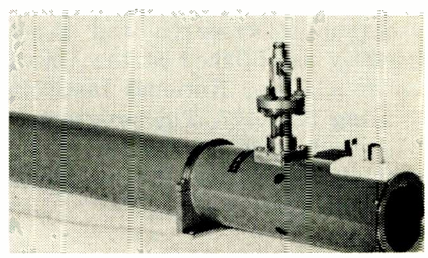
Microwaves—Past, Present & Future



High Power TWT's

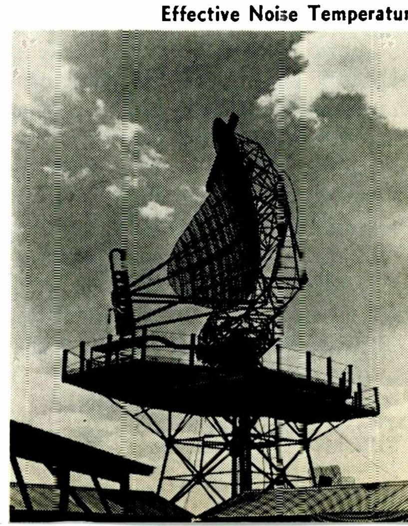


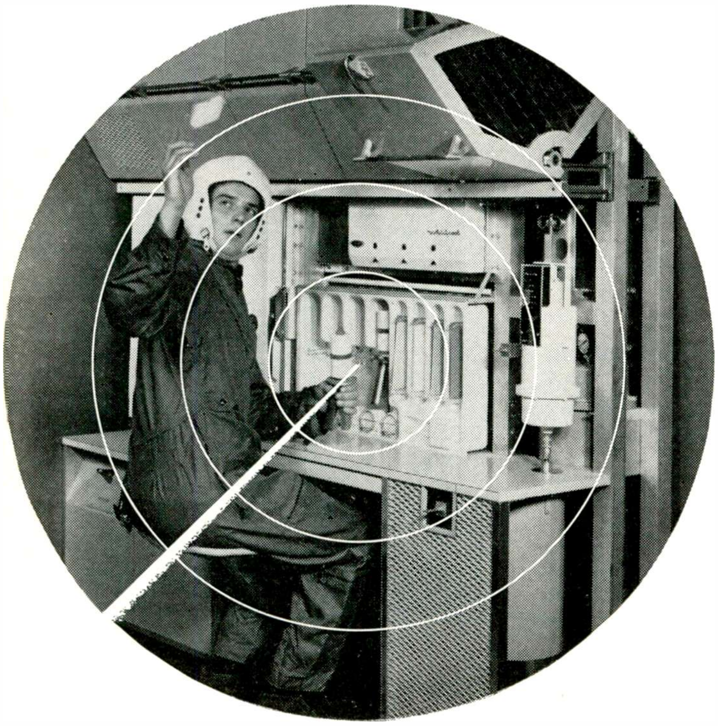
Microwave Component Testing



Flat Response TWT

Effective Noise Temperature





SPACE KITCHEN

How to hold food down while it is being cooked under conditions of weightlessness is just one of the problems that is solved in this experimental space kitchen designed by Whirlpool Corp. This model is a permanent part of the Aries space station, featured in the "Man in Space" exhibit at N.Y.'s Museum of Natural History.

BIOMEDICAL ENGINEERING seminar course, the first of its kind in the U.S., is being given this semester at the Univ. of Rochester. The biomedical program of research and graduate training was recently established at the University of Rochester under a 5-year National Institutes of Health grant totaling $254,407. The program of graduate studies will lead to a Ph.D. degree in engineering with special application in the fileds of medicine and life sciences.

UNITED KINGDOM EXPORTS of electronic products in the U.S. in the first quarter of this year totaled over $4.5 million, up 6% from the same period of 1960, according to the Electronics Div., Business & Defense Services Administration, U.S. Dept. of Commerce. Exports of record playing mechanisms accounted for over one half of the total value of electronic products to the U.S. They increased by 26% in this first quarter, but exports of record players, radios, and phonographs dropped sharply. The United Kingdom exports of electronic products to all countries during January to March 1961, totaled 48.7 million, a 26% increase over the 38.5 million total in the first quarter of 1960. The U.S. was the largest single market, followed closely by Canada.

RESEARCH AND DEVELOPMENT performed by private industrial firms in 1960 amounted to 10.5 billion, according to the National Science Foundation. This represented a 10% increase over the 9.6 billion total for 1959. Of the 10.5 billion, 58% was financed by the Federal Government. A few industries far surpassed all others in funds for R&D performance; the aircraft industry with 3.5 billion and the electrical-electronic equipment and communications, 2.4 billion.

FUEL CELLS will serve as power sources in special applications within the next 5 years, if the present heavy research is continued. And fuel cells to furnish electricity at home are "entirely conceivable." This opinion was delivered to the AIEE Fall General Meeting by James D. Flynn of Cincinnati Gas & Electric Co. Backing up this view, he pointed out that more than 60 government and industrial fuel cell projects, costing $28 million annually, are now under way.

NEW SATELLITE INSTRUMENTATION is under development at Armour Research Foundation for the Air Force. Instrumentation will measure man-made microwave frequency interference encountered by space vehicles and communication satellite. When put into orbit, electronic gear will measure electromagnetic environment in outer space, providing information for selection of frequency bands for future space communications systems.

LUNAR ROVERS

At the American Rocket Society exhibitions in New York's Coliseum, Mrs. Judith Wrona introduces two of RCA's strange moon devices, known as "Lunar Rovers," designed for exploration on the Moon.

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

THE RENEGOTIATION BOARD has adopted a streamlined single form to be used by defense subcontractors in reporting renegotiable business. The board currently receives approximately 4,000 filings per year from firms having an excess of $1 million of renegotiable business in a fiscal year.

SOLDERING ALUMINUM to stainless steel at low temperatures is now possible through a flux-free method developed by the Atomic Energy Commission. The new solder joint provides a gas-tight durable bond. Using other soldering techniques, occlusion of flux invariably destroys the joint through electrolytic action.

NEW MATERIALS RESEARCH program has been initiated on a $11 million contract to the University of North Carolina. The Advanced Research Projects Agency of the Dept. of Defense is putting up the money. The government is establishing eight of these inter-disciplinary laboratories at universities around the country. These new ventures in which the universities will assemble faculties and students and create advanced facilities, will, for the first time, combine modern progress and solid state physics, chemistry, metallurgy, mechanics, applied mathematics and other related fields.

MIAMI'S MUCH-TROUBLED CHANNEL 10 will have a new licensee next month. The FCC has refused to renew the license of Public Service Television, Inc., a sub. of National Airlines, which has been transmitting on Channel 10 for 4 years. It is the first time the Commission has taken away a license of an operating television broadcaster. The reason given was its back-door tactics in obtaining the channel. Of the four original applicants, the FCC found that three had employed unethical methods in competing for the franchise. Only one, L. B. Wilson, Inc., was found free of taint.

THE CHICAGO AREA ELECTRONICS INDUSTRY heard the reports at the National Electronics Conference that they are not keeping pace with East and West Coast industries in advanced research developments. The results of a Northwestern University survey point out definite deficiencies in the Chicago Area Research in the new areas of electronics such as solid-state components, electronic data processing, microwave systems, weapon systems, command and control systems, and sophisticated instrumentation. The lack of emphasis on R&D accounts for some of the area's failure to recruit and retain the outstanding researchers and scientists, the report indicates. The situation is attributed in part to the lack of adequate programs with local universities for company-sponsored advanced degrees, cooperative research projects, and participation in research seminars.

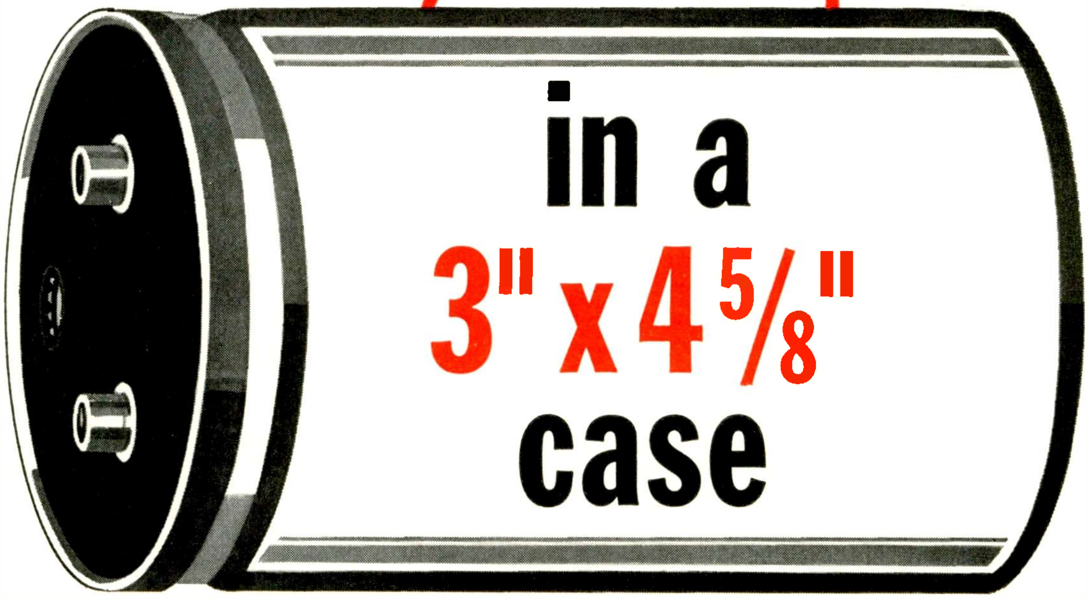
NEW CERAMIC-METAL COATINGS called Nucerite are available on limited production basis from Pfaudler Co. Nucerite coating is a ceramic-metal composite consisting of ceramic structure characterized by large number of very small crystals physically and chemically bonded to structural substrate. They possess good resistance to high temperature, corrosive attack at temperatures between 500° and 1500°F.

CURRENT R&D in the field of automatic character reading equipment for data processing machines is characterized as "progress, paradox and promise" by the National Bureau of Standards. Progress, says NBS, has not been what might be expected, considering the great potential of this equipment. The Bureau has released a new state-of-the-art report, automatic character recognition, which is available through the Office of Technical Services, Business & Defense Administration, U.S. Dept. of Commerce, Washington 25, D.C. While admitting that "there has indeed been progress," it has been rather less than might have been expected because "the domain of potential applicability (of such technique) is so widespread."

FAR OUT POWER

Technician at Hughes Aircraft Co.'s Research Lab., Malibu, Calif., works on an experimental ion engine. Designed for powering exploratory space flights to the farthest planets, the engine uses electrostatic propulsion to gain thrust by ionizing cesium atoms and accelerating them from the rear of the engine.

150,000 µF



*Powerlytic** **Capacitors are packed with capacitance!**

Designed specifically for applications requiring maximum capacitance in small physical size, Sprague Type 36D Aluminum Electrolytics find wide use in power supplies for digital computers, industrial controls, high-gain amplifiers, and allied equipment. Furnished in case sizes ranging from 1⅜" dia. x 2⅛" long to 3" dia. x 4⅝" long, Powerlytic Capacitors are available with capacitances which were previously impossible to obtain in the various case sizes.

Engineered for 65 C Operation

In Powerlytics, Sprague's many years of research, design, and production experience have produced a capacitor which allows the equipment designer maximum space economy for operating temperatures up to 65 C. This encompasses the great majority of applications in transistorized digital equipment and similar apparatus.

Outstanding Performance Characteristics

Powerlytic Capacitors have not only low ESR and low leakage currents but offer extremely long shelf life as well. Furthermore, they have the ability to withstand unusually high ripple currents.

Superior Seal and Safety Vents

Type 36D Powerlytics use the most reliable seal that Sprague has developed for aluminum electrolytic capacitors. This consists of crimping a beaded aluminum can onto a rubber gasket recessed in a rigid molded cover. Pressure-type safety vents employing silicone rubber are used on all case covers.

Choice of Terminal and Insulating Tube Styles

Tapped terminal inserts, often preferred for strap or bus bar connections, are available as well as solder lug terminals for use with permanently wired connections. In addition to the standard bare case, Powerlytic Capacitors may also be obtained with a new clear skin-tight plastic tube which adds very little to the bare case dimensions. They are also available with a Kraftboard tube.

Broad Range of Standard Ratings

Sprague's standard line of Powerlytic Capacitors includes 183 ratings covering capacitance values from 45 to 150,000 μF, in voltages from 3 to 450 WVDC. Each rating is the maximum capacitance available for a given case size.

• • •

For complete technical data on Type 36D Powerlytic Capacitors, write for Engineering Bulletin 3431 to Technical Literature Section, Sprague Electric Company, 233 Marshall Street, North Adams, Massachusetts.

*trademark

SPRAGUE COMPONENTS

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

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THE MARK OF RELIABILITY

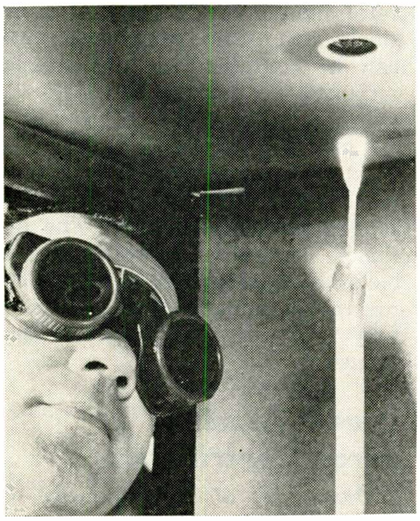
As We Go To Press . . .

Univac Dedicates Engineering Center

Remington Rand Univac recently dedicated their new engineering center in Blue Bell, Pa. The $20 million research center, containing 300,000 square feet, employs over 1,050 people. Of this total 700 are engineers, scientists and technicians working in 25 separate laboratories. They are engaged in basic and advanced research, product design, quality assurance and human engineering projects.

Speakers at the dedication ceremonies included Pa. Lt. Gov. John Morgan Davis, Dr. Gaylord P. Harnwell, president of the University of Pa.; Dause L. Bibby, president of the Remington Rand division of the Sperry Rand Corp.; and J. Presper Eckert and Dr. John W. Mauchly, co-inventors of the Eniac and Univac computers.

GEM FACTORY



Scientist observes growth of synthetic ruby crystal through a flame fusion process at Hughes Aircraft Company's research labs at Malibu, Calif. The labs make experiments with ruby gems for use in its laser, a device that emits a "coherent" light beam.

Form Data Systems Group

Radio Corporation of America has formed a data systems division in Van Nuys, Calif. It has been organized out of the West Coast missile and surface radar division which for the past two years has been operating out of the Van Nuys plant. The new name will replace that formerly used and the new division will absorb activities of the former division. Harry R. Wege has been named vice president and general manager of the division.

GUN CONTROL SYSTEM

Engineers use Servoscope ® servo system analyzer to make dynamic analysis of tank gun elevating and turret traversing control system developed by Minneapolis-Honeywell. Test instrument made by Servo Corp. of America, Hicksville, L. I., N. Y., was key check-out for analyzing electrical characteristics and performance of gyroscope-stabilized "dynamic gun/turret control system."

Railway Expands Microwave System

GE has been contracted to expand microwave facilities of the Southern Railway System. The railroad is already engaged in installing the largest industrial microwave system in the U. S.

GE's Communication Products Department, Lynchburg, Va., will supply a multi-channel transistorized communications design built for high channel capacity. It will be used in a new microwave network to be installed by Southern between Cincinnati, Ohio; Atlanta, Ga.; and Birmingham, Ala.

MODEL SATELLITE

Bell Telephone Laboratories engineers B. R. Cheo (left) and W. D. Baker prepare developmental model of a Bell System communications satellite for transmission experiments. The satellite is scheduled for launching next spring.

Midget MISSILE MASTER Accepted by the Army

A midget MISSILE MASTER, much cheaper than its large size counterpart and which can be operated with a tremendous saving in electric power and personnel, has been accepted for use by the Department of the Army. Installation of the first of 19 such pocket-sized air defense coordination systems, designed to help protect military installations, or cities in the 600,000 population class, has been completed.

The new transistorized system, called BIRDIE, processes and distributes information about aircraft to guided missile batteries and coordinates Nike Ajax and Nike Hercules missile fire. It can operate independently in its own area or as part of an over-all system. The average Martin Co. BIRDIE costs approximately half a million dollars.

Jet Simulator Contract Awarded

A contract for more than $1,000,000 has been received by the Link Division of General Precision, Inc., Binghamton, N. Y., from United Airlines for the manufacture of a jet simulator of the Boeing 727 turbo-jet transport.

United Airlines is currently operating two Link DC-8 simulators and a Link 720 simulator at their Denver, Colorado training center. This center has one of the world's largest concentrations of electronics equipment for flight crew training.

More on Page 8

Electronic SHORTS

▸ **Largest commercial sale of electronic data processing equipment ever made, and the signing of a patent licensing and technical information agreement, have been announced by the Radio Corporation of America and Compagnie des Machines Bull of Paris, France. Under the multi-million dollar international agreement, Machines Bull has placed an initial order with RCA for the purchase of a minimum of 50 and a maximum of 100 RCA data processing systems.**

▸ A technical study to establish requirements for an airborne data processing system for fixed-wing anti-submarine warfare aircraft has been awarded to Loral Electronics Corporation by the U. S. Naval Air Development Center, Johnsville, Pa. Two subcontractors, Cornell Aeronautical Laboratories, Buffalo, N. Y., and Amelco, Inc., Los Angeles, Calif., will assist in the study.

▸ **Bureau of Naval Weapons has awarded Vocaline Co. of America, Inc. a contract to operate and maintain a quality control test range for sonobouys at the company's facilities in Maine. Sonobuoys are electronic submarine detecting devices used in anti-submarine warfare.**

▸ Page Communications Engineers, Inc., will design and build two long-distance VHF ground-air-ground antenna arrays for the Federal Aviation Agency. They will be used in tropospheric-scatter experiments to determine if this type of communications can be used in long-distance air traffic control.

▸ **A manipulator designed to operate in outer space has been developed by The General Mills Electronics Group at Minneapolis. Design studies have established the feasibility and delivery of a remotely controlled manipulator which could operate on the surface of the moon.**

▸ World's most powerful ion accelerator is now being installed by Langley Research Center of the National Aeronautics & Space Agency, Langley Field, Va., and will be used to study the effects of radiation in space on space vehicle equipment. The electron beam accelerator was manufactured by Radiation Dynamics, Inc., Westbury, N. Y.

▸ **Optics Technology, Inc., Belmont, Calif. has received an Air Force contract calling for research and development in infrared fiber optics. The project will include investigations in methods of extending coated and uncoated crystalline fibers, methods of hot drawing coated fibers, and the fabrication of infrared fiber optics devices.**

▸ The Armament Div. of the Universal Match Corp., St. Louis, Mo., has received a $2.1 million contract from the Army Ballistic Missile Agency (ABMA) for quantities of Transporter-Erector-Launchers (TEL) for the Pershing Missile. The rugged mobile units are designed for fast and efficient handling and launching of the Pershing, a solid propellant surface-to-surface ballistic missile.

▸ **U. S. Air Force has selected Federal Electric Corp., service associate organization of I. T. & T., as prime contractor for tropospheric-scatter communication equipment for use in Europe. The multi-million dollar project will provide tropospheric-scatter communications to augment existing Air Force communication facilities.**

▸ A study contract for design of a new electronic aid to aviation safety has been awarded The Martin Company's Orlando Division by the Federal Aviation Agency. Contract involves design of an automatic method for transferring aircraft in flight from the control of an air route traffic center to an airport control tower.

▸ Three Two-Way Doppler Tracking Systems for shipboard operation on the Pacific Missile Range will be produced by General Dynamics/Electronics, Rochester, N. Y. The systems will include tracking antennas, UHF transmitters, extremely sensitive phase-lock receivers, and data processing and recording equipment.

▸ **NASA has awarded Electro-Optical Systems, Inc., Pasadena, Calif., a contract for a feasibility study of a laser beacon for daylight tracking and navigational purposes. Work will be performed by the company's Quantum Physics Division.**

As We Go To Press (cont.)

Sampler Explores Upper Atmosphere

Successful operation of an advanced upper atmosphere sampling system has been announced by the Aerolab Development Co. in Pasadena, Calif. Known as the Cryogenic Sampler, the collector was rocket launched at White Sands Proving Ground to 50 miles altitude by the U. S. Navy Aerobee Launch Facility. It was developed under a contract to Aerolab from the Geophysics Research Directorate of the Air Force Cambridge Research Labs.

After the nose cone of the rocket is discarded, the door of the sampler is opened at about 25 miles altitude. All air, particles, and organisms encountered by the open diffuser mouth as the rocket rises are gulped in and stored. As the volume of the sample chamber is limited, the sample is reduced in size by cooling down the atmospheric gases as fast as they come in to liquid hydrogen temperature. The total sample in the form of frozen slush and some remaining gases can be contained in the sampler, although in rising to 50 miles everything in 21,000 cubic feet of air has been collected.

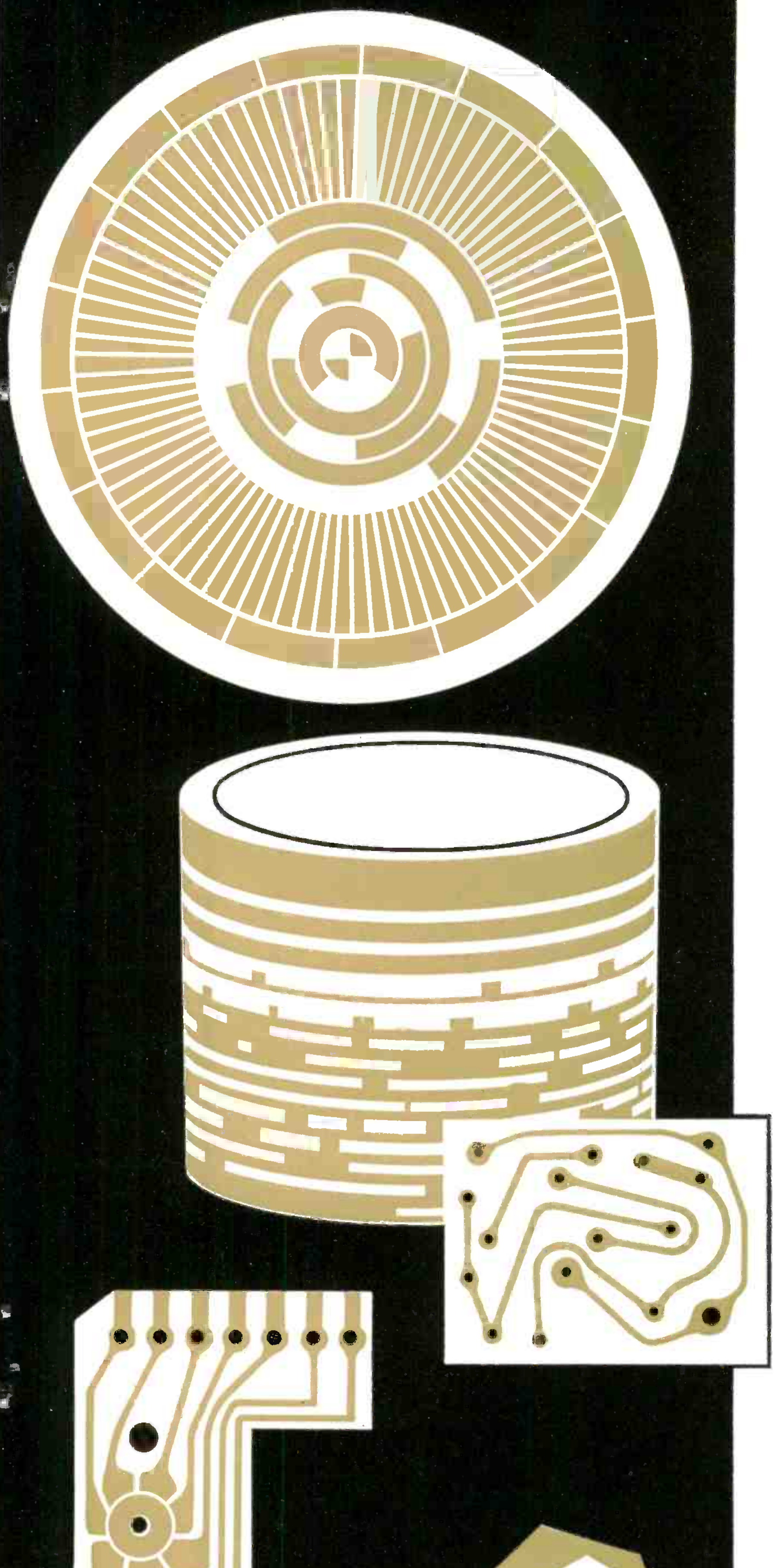
At the end of sampling the door is closed and the sampler returns to ground by parachute. The system is designed to retain the sample under high pressure as it warms up and returns to a gas. Laboratory analysis can later be performed.

U of P Receives Large Contribution

University of Pennsylvania has received contributions having a value of more than $1 million from the Remington Rand division of Sperry Rand Corp. Contributions were in appreciation of the University's pioneering role in the developing of the electronic computer industry.

A Univac Solid-State 80 computing system was the major contribution. It will supplement a Univac I which was presented to the University by Remington Rand in 1957.

In addition to the new computer system, four fellowship grants will be provided. Also, a group of advanced computer experts will be assigned to the University for the advancement of the institution's computer research and education programs.



Coming Events in the electronic industry

Nov. 7-10: Packaging Machinery Mfgs. Institute Show of 1961; Cobo Hall, Detroit, Mich.

Nov. 8-9: Symp: Prototype & Short Run Tooling Methods: ASTME; Belmont Plaza Hotel, New York, N. Y.

Nov. 8-11: 62nd Mtg. Acoustical Soc. of America, the Tech. Committee on Sonics and Ultrasonics Eng'g., IRE (PGUE); Cincinnati, Ohio.

Nov. 9-10: Mtg. Operations Research Soc. of America; Jack Tar Hotel, San Francisco, Calif.

Nov. 9-10: 5th Annual Display of the Aerospace Electrical Soc.; Balboa Park, San Diego, Calif.

Nov. 9-11: 2nd Power Industry Computer Application Conf., AIEE; Chase Hotel, St. Louis, Mo.

Nov. 13-16: 7th Annual Conf. on Magnetism and Magnetic Materials, AIEE, AIP, ONR, IRE, Metallurgical Soc. of AIME; Hotel Westward Ho, Phoenix, Ariz.

Nov. 14: Symp. on Electronic Systems Reliability (MAECON scheduled only on even years), Kansas City Sec. IRE; Kansas City, Mo.

Nov. 15: Vinyl Plastics in the Household, N. Y. Sec. with Cooperation of Vinyl Plastics PAG; Statler-Hilton Hotel, New York, N. Y.

Nov. 15-17: 19th Annual Aerospace Electrical Soc. Display; Pan Pacific Auditorium, Los Angeles, Calif.

Nov. 15-18: Annual Mtg. Soc. of Naval Architects and Marine Engineers; Waldorf Astoria Hotel, New York, N. Y.

Nov. 16: 35th Annual Mtg. of NEMA; The Plaza Hotel, New York, N. Y.

Nov. 17-18: Mtg. American Mathematical Soc.; Milwaukee, Wis.

Nov. 20-21: 1961 Electron Devices Mtg.; IRE (PGED); Shoreham Hotel, Washington, D. C.

Nov. 24-25: American Physical Soc. Mtg.; Chicago, Ill.

Nov. 26-Dec. 1: Annual Winter Mtg. ASME; Statler-Hilton Hotel, New York, N. Y.

Nov. 27-Dec. 1: 28th Exposition of the Chemical Industries; Coliseum, New York, N. Y.

Nov. 30-Dec. 1: Conf. of Professional Group on Vehicular Communications, IRE; Radison Hotel, Minneapolis, Minn.

Nov. 30-Dec. 2: Conf. Technical Progress in Communication — Wire & Cables Symp., U. S. Army (Sig. R&D Labs.); Berkeley - Carteret Hotel, Asbury Park, N. J.

INTERNATIONAL

Nov. 8-10: Conf. on Non-Destructive Testing in Electrical Engineering, Institution of Electrical Engineers (BRIT.); London, England.

Nov. 13-18: 9th Factory Equipment Exhibition; Earls Court, London, England.

Highlights of '61

Nov. 14-16: 1961 Northeast Electronics Research and Eng'g. Mtg. (NEREM), IRE; Commonwealth Armory and Somerset Hotel, Boston, Mass.

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

DECEMBER

Dec. 1: Plastics Screw Injection Molding, Cleveland Sec. SPE; Cleveland Eng'g. Soc. Bldg., Cleveland, Ohio.

Dec. 2-5: 5th Annual Internat'l. Visual Communications Congress, Soc. of Reproduction Engineers, AID, ARMA; Biltmore Hotel, Los Angeles, Calif.

Dec. 6-7: Symp. Electric Machining & Forming, ASTME; Statler-Hilton Hotel, Hartford, Conn.

Highlights '62

IRE Internat'l. Conv., Mar. 26-29, Coliseum & Waldorf-Astoria Hotel, New York, N. Y.

WESCON, Aug. 21-24, IRE, WEMA; Los Angeles, Calif.

Nat'l. Electronics Conf., Oct. 9-11, IRE, AIEE, EIA, SMPTE; Chicago Ill.

NEREM (Northeast Res. & Eng. Mtg.) Nov. 13-15, IRE; Boston, Mass.

Dec. 6-8: 65th Annual Congress of American Industry, NAM; Waldorf Astoria, New York, N. Y.

Dec. 6-8: 19th Electric Furnace Conf., AIME; Penn-Sheraton Hotel, Pittsburgh, Pa.

Dec. 18: Wright Brothers Lecture, IAS; Washington, D. C.

Dec. 26-31: Annual Mtg. and Exposition of Science and Industry, American Assoc. for the Advancement of Science; Denver-Hilton Hotel, Denver, Colo.

Dec. 27-29: Mtg. of the American Physical Soc.; Los Angeles, Calif.

Dec. 27-30: Annual Mtg. American Statistical Assoc.; Roosevelt Hotel, New York, N. Y.

1962

Jan. 9-11: 8th Nat'l. Symp. on Reliability & Quality Control, IRE; Statler-Hilton Hotel, Washington, D. C.

Jan. 29-Feb. 2: Winter General Mtg. & Electrical Engineering Exposition, AIEE; Coliseum, New York, N. Y.

Feb. 6-7: Symp. on Redundancy Techniques for Computing Systems, ONR(ISB); Dept. of the Interior Auditorium, Washington, D. C.

Feb. 7-8: Automatic Production-Numerical Control, ASTME; Statler-Hilton Hotel, Cleveland, Ohio.

Feb. 7-9: 1962 Winter Conv. on Military Electronics, IRE (PGME), L. A. Sec. IRE; Ambassador Hotel, Los Angeles, Calif.

Feb. 14-16: 9th Annual Internat'l. Solid-State Circuits Conf., IRE, AIEE, U. of Pa.; Sheraton Hotel and Univ. of Pennsylvania campus, Philadelphia, Pa.

Mar. 10-13: Internat'l. Watchmakers and Mechanical Instrumentation Cong.; Hotel Commodore, New York, N. Y.

Apr. 9-13: The Business Equipment Exposition, OEMI; McCormick Place, Chicago, Ill.

Apr. 11-13: 1962 Southwestern IRE Conf.; Houston, Tex.

Apr. 25-29: Western Space Age Industries & Eng'g. Expos./Conf.; Cow Palace, San Francisco, Calif.

May 1-3: Spring Joint Computer Conf., AFIPS; San Francisco, Calif.

May 8-10: 1962 Electronic Components Conf., AIEE, EIA, IRE; Marriott Twin Bridges Motor Hotel, Washington, D. C.

June 17-22: Summer General Mtg. AIEE; Denver, Colo.

June 25-27: 6th Nat'l. Conv. on Military Electronics (MIL-E-CON); Shoreham Hotel, Washington, D. C.

Sept. 18-19: 1962 Conf. on Rectifiers in Industry, AIEE; Deshler-Hilton Hotel, Columbus, Ohio.

Oct. 7-12: Fall General Mtg. AIEE; Chicago, Ill.

Oct. 15-19: 17th Internat'l. Instrument-Automation Conf. & Exhib. and ISA Annual Mtg.; Coliseum, New York, N. Y.

(*Continued on page* 12)

Coming Events

(*Continued from page 11*)

ENGINEERING EDUCATION

Short Courses at leading institutions, of interest to Electronic engineers.

Michigan State University, East Lansing, Mich., Electrical Eng'g Dept. & Computer Lab. Fall Quarter Seminar — **Nov. 14:** An Algebraic Compiler for the Mistic; **Nov. 21:** Factory Simulation by Computer; **Nov. 28:** A Drum Translating Compiler; **Dec. 5:** FM Multiplex. Information on the above may be obtained from Dr. R. J. Reid, Seminar Chairman at the above address.

University of Wisconsin, Extension Div., offers an Industrial Engineering Seminar **Nov. 14-15.** For information write to Engineering Institutes, 3030 Stadium St., Univ. of Wis., Madison 6, Wis.

University of Michigan, Ann Arbor, Mich. offers a seminar "Effective College Recruiting" **Dec. 7-8.** For information contact Clark C. Caskey, program director, U-M Bureau of Industrial Relations, Ann Arbor, Mich.

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

CALL FOR PAPERS

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

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

Do you have any of these transient analysis problems?

Development of a unique new instrument—the Hughes High-frequency Memo-scope® Oscilloscope—now makes solving transient analysis problems quicker, easier and more economical. Secret of this instrument is its ability to freeze high frequency impulses until intentionally erased. It is the only instrument on the market today that can give you stored response at fast writing speeds! Here are six case histories which demonstrate the types of problems which can be solved:

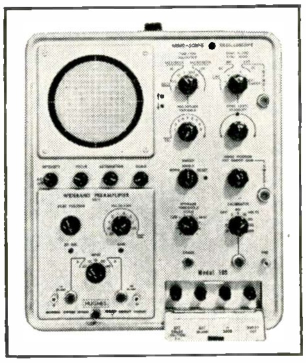
Low Level Signal Data Processing—A leading West Coast research facility used the Memo-scope oscilloscope for passive satellite tracking. The instrument was able to integrate very small signal levels over a very high random noise level. Result: the company was able to track satellites in an environment where the noise amplitude actually exceeded the signal amplitude.

Quality Control Inspection—A large Eastern firm uses the Memo-scope oscilloscope to dramatically improve the reliability levels of incoming components and systems which were subject to transient behavior. Typical items tested included relays, switches, coils, capacitors, diodes, transistors, transformers, and complete computer and servo systems.

Shock and Impact Testing—A well-known missile manufacturer used the Memo-scope oscilloscope to calibrate accelerometers. Using a Model 105 Memo-scope oscilloscope, with a Multitracer Unit, this firm was able to compare a shock signal from a "calibrated standard" accelerometer against newly purchased units and those undergoing their periodic checks.

Medical Research—A large Texas medical institution used this unique Hughes instrument for a study of the human nervous system. They were able to obtain an early diagnosis of nervous system deterioration by measuring the exact elapsed time that an electrical pulse takes to pass between two points in the central nervous system.

Welding Control—To permit high-reliability welding of metals, a leading Southern California aircraft and missile manufacturer uses the Memo-scope oscilloscope as a precision monitoring device. They were able to precisely control heat, pressure and time throughout the entire welding process.



System Check-out: Production and Field—A well-known aircraft manufacturer used the Memo-scope oscilloscope as a key element in a check-out console. The communications and radar automatic gain controls, as well as the servo systems adjustments, were precisely monitored. It was also used in cross-talk analysis; interference monitoring; stress, vibration and flutter analysis; and general trouble-shooting.

SPECIFICATIONS

Conventional Mode:

- DC to 10 mc Band Pass
- Sweep Range: 0.1 μ secs/division to 1 sec/division; 5X Magnifier for speeds to .02 μ secs/division; Multiplier for sweeps long as 10 secs/division
- Rise Time: 35 nanoseconds
- Built-in Delay Line (0.25 μ secs)
- Numerous Trigger Selections
- Plug-in Preamplifiers

Storage Mode:

(All features of Conventional Mode, PLUS:)

- One million inches per sec Writing Speed
- Unlimited Storage Time
- Fast Erase (less than 150 millisecs)
- X-Y Plotting
- Single Shot Trigger
- Photograph or Trace Directly Off Scope Face

If you have a transient analysis problem and would like a complete technical data sheet, you are urged to write: **Memo-scope Oscilloscope, Vacuum Tube Products Division, Hughes Aircraft Company, 2020 Short Street, Oceanside, California.**

As We Go To Press . . .

ARTIFICIAL SUN

D. Bickler, solar measurements specialist, takes readings from a monochrometer and verifies that light output from solar simulator developed by Hoffman Electronics Corp. has the same qualities as actual sunlight in outer space.

NASA Names Industrial Executive to Key Post

D. Brainerd Holmes has been named Director of Manned Space Flight Programs by the National Aeronautics and Space Administration. The announcement was made by James E. Webb, space agency administrator.

Mr. Holmes is an industrial executive known for his ability to bring multi-million dollar government projects in on time and within predictable costs. He is at present General Manager, Major Defense Systems Division, a unit of RCA Defense Electronic Products, Moorestown, N. J. He has served in this capacity for three and one-half years as RCA's project manager of the Ballistic Missile Early Warning System (BMEWS).

Corporation to Fulfill Army's Research Needs

The Research Analysis Corporation, Bethesda, Md., a private, non-profit organization of experienced scientists, has begun operations to help bolster the strategic, tactical and management capabilities of the U. S. Army through scientific research and analysis.

RAC has contracted to perform the major portion of the Army's Operations Research. Mr. Frank A. Parker, Jr., formerly Assistant Director of Defense Research and engineering in the office of the Secretary of Defense, heads the new research organization. RAC is strictly a scientific advisory organization. Conclusions of its studies take the form of findings and recommendations which are intended to assist the Army's decision-makers.

Signal Corps Award To General Instrument

U. S. Army Signal Corps has presented to General Instrument Corp.'s Semiconductor Division its special award for quality production. It is the second consecutive year that the RIQAP (Reduced Inspection Quality Assurance Plan) certificate has been awarded to General Instrument. It was given for "consistent production of high-quality electronic products for the armed forces" and the most rigid internal quality control procedures, which reduce the amount and cost of product inspection by the Government. The General Instrument Semiconductor Division has principal plants at Newark, N. J., Hicksville, L. I. and Woonsocket, R. I.

Comb-Filter System Contract Awarded

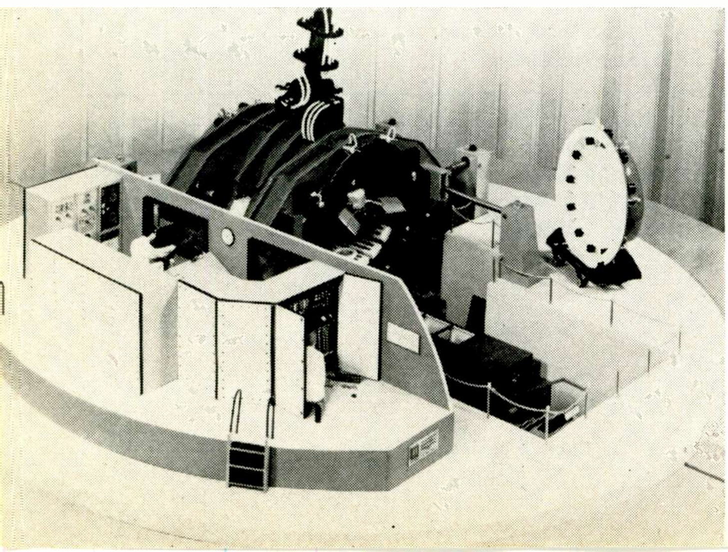
Bell Telephone Laboratories has awarded a contract to Itek Electro-Products Co., Cambridge, Mass., for design and manufacture of two comb-filter spectrographic systems for AT&T's space communications program.

The systems will be installed in the Rumford, Me., ground station and will detect the tracking beacon of the first commercial communications satellite, to be launched in April, 1962, and its successors. Systems will survey a frequency spectrum supplied by a receiver, detect any Doppler returns, and identify their frequency within a few cycles.

Itek will supply the precision narrow-band crystal filters, and the detector, threshold, post-detection, and amplifier circuits for the 300 channels used in the Bell Labs equipment.

RADAR AIDS SMALL PLANES

Lois Martin of RCA's Aviation Equipment Department holds indicator unit for new RCA AVQ-55 system. Designed especially for small twin-engined aircraft the system's three basic units — the indicator, the transmitter-receiver and antenna — have a combined weight of less than 40 pounds.



RATE CONTROLLER

Automatic Digital Rate Controller (ADRC) built by Computer Control Co., Los Angeles, will help simulate earth's movement in this environmental space lab being built by Minneapolis-Honeywell Regulator Co. It will be used to test space reconnaissance vehicles.

ASTM Changes Name

Name of the American Society for Testing Materials has been officially changed to the American Society for Testing AND Materials. Signing of a court decree amended the Society's Charter originally granted in 1902 by the Commonwealth of Penna. Inclusion of the word "and" in the Society's name places added emphasis on the Society's research work in seeking knowledge of the nature of materials, according to ASTM President Miles N. Clair.

New from Sprague!


TO-9 CASE

The Most Widely-Used Logic Transistor, Type 2N1499A, Now Has a Smaller Brother...

TYPE 2N979


TO-18 CASE

LOW-COST LOGIC TRANSISTOR

Here is a new Sprague Transistor that is smaller in size, yet identical in performance with the well-known 2N1499A Logic Transistor.

Designed for use in saturated switching circuits, this low-cost, hermetically-sealed MADT® Transistor is capable of switching at frequencies in excess of 10 megacycles.

In addition to computer applications, this rugged transistor is ideally suited for data processing and instrumentation equipment.

There are two major reasons why The Sprague 2N979, as with the 2N1499A, is earning a high level of acceptance:

1. DEPENDABLE PERFORMANCE — Specifically designed with parameters intended for logic circuits, these transistors consistently show low storage time, low saturation voltage, high beta, high switching speed. Their cases are cold welded to insure reliability.

2. ATTRACTIVE PRICE — Available in production quantities, these transistors are first-run devices, *not* "fall-outs". They are produced on FAST (Fast Automatic Semiconductor Transfer) lines with direct in-line process feedback, especially programmed to insure high production yields.

Here are some key parameters:

I_{CBO}	1 μa typ.
BV_{CBO}	20V min.
BV_{CES}	20V min.
f_T	100 mc min.

For application engineering assistance without obligation, write Transistor Division, Product Marketing Section, Sprague Electric Co., Concord, New Hampshire.

For complete technical data, write Technical Literature Section, Sprague Electric Company, 233 Marshall Street, North Adams, Mass.

SPRAGUE COMPONENTS

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

SPRAGUE®
THE MARK OF RELIABILITY

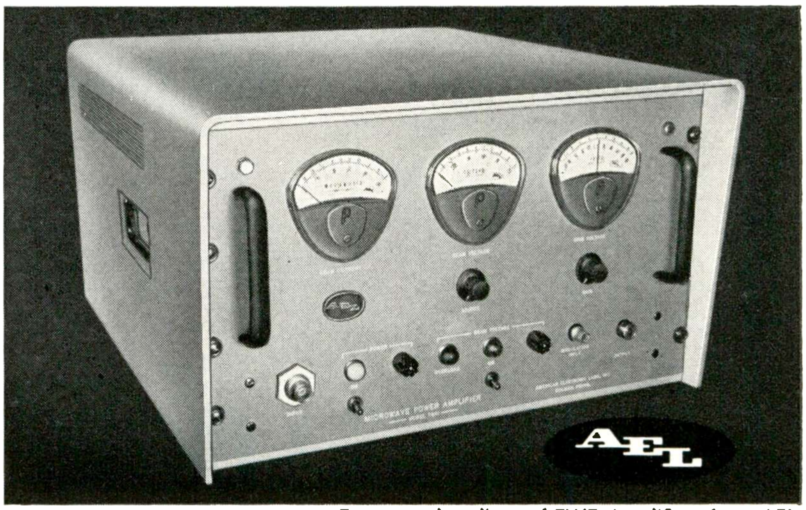
Circle 7 on Inquiry Card

no other line of MICROWAVE POWER AMPLIFIERS offers you all these characteristics

. . . A powerful statement . . . backed up by the AEL TWT Amplifiers described here

- Permanent magnet focusing on all tubes — eliminates need for tube alignment — also eliminates need for heavy solenoids and solenoid power supplies.
- Ruggedly built for long service under rough conditions . . . heavy gauge aluminum construction.
- Three separate meters for simultaneous indications of beam current, beam voltage and grid voltage.
- Continuously variable gain controls.
- CW, pulsed or AM modulated operation.
- Designed for safety of personnel and tube . . . high voltage interlocks . . . overcurrent and filament protection.

. . . also note characteristics and prices noted below



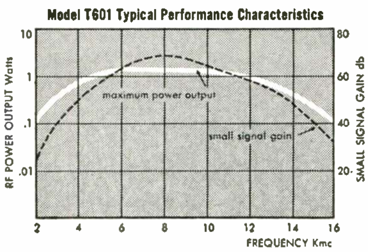
Two complete lines of TWT Amplifiers from AEL

AEL EXTREMELY BROADBAND medium power amplifiers

MODEL T601

2 to 16 Gc total bandwidth

. . . with 1 watt output guaranteed over 5 to 11 Gc . . . with 50 db small signal gain.

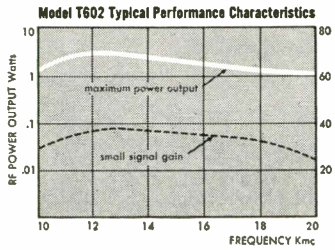


price: $3,990.

MODEL T602

10 to 20 Gc total bandwidth

. . . with more than 1 watt output guaranteed from 12 to 18 Gc. Although not guaranteed at this time, 1 watt output may be expected over the entire range 10 to 20 Gc. Gain guaranteed to exceed 30 db from 12 to 18 Gc.



price: $4,950.

AEL LOW POWER AMPLIFIERS

Specifications and prices

Model Number	T603	T604	T605	T606
Frequency, Gc	1-2	2-4	4-8	8-12
Min. Pwr. Out, Milliwatts	15	10	10	5
Min. Small Sig. Gain, db	35	35	35	35
Price	$1,795.	$1,795.	$2,100.	$2,100.

AEL MEDIUM POWER AMPLIFIERS

Specifications and prices

Model Number	T607	T608	T609	T610
Frequency, Gc	1-2	2-4	4-8	8-12
Min. Pwr. Out, Watts	1	1	1	1
Min. Small Sig. Gain, db	30	30	30	30
Price	$1,925.	$1,925.	$2,750.	$2,750.

Creative engineers are urged to investigate the rewarding opportunities at AEL

AEL

American Electronic Laboratories, Inc.

RICHARDSON ROAD, COLMAR, PENNSYLVANIA

Just north of Philadelphia

Now Mincom offers the industry extended bandwidth and improved predetection recording...the MINCOM Series CM-100 Instrumentation Recorder/Reproducer

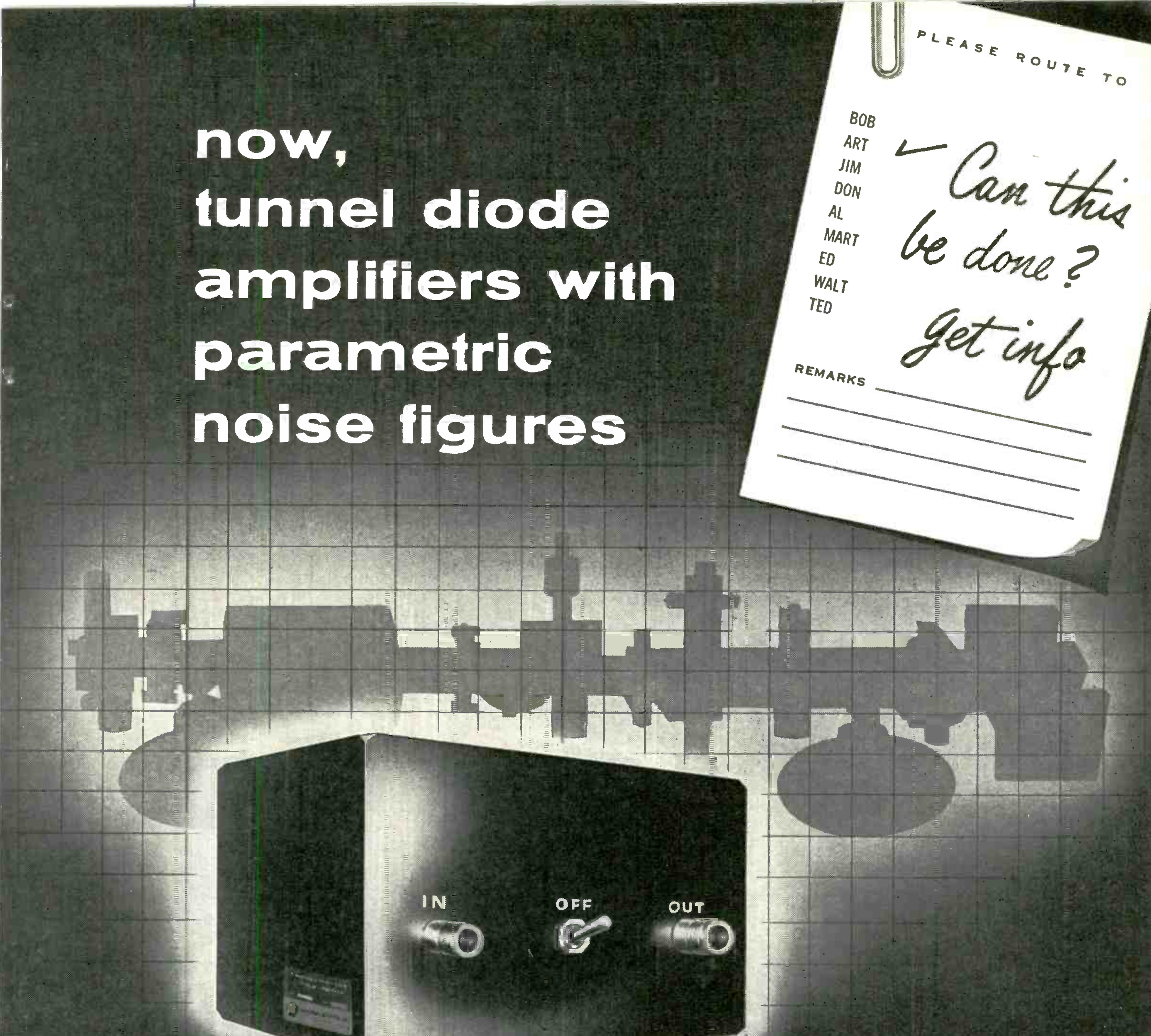
At 120 ips the Mincom Series CM-100 now delivers 1.5 mc*—and also makes possible predetection recording/reproducing with dropouts virtually reduced to zero. This superb improvement in predetection performance is accomplished by redundant data recording. The two carrier tracks are fed through a new and exclusive Tracklok® to eliminate skew, and thence as a single track into a demodulator to recover the original information. It's well worth seeing, especially if you need reliable operational predetection at your facility—and need it in FM/FM modulation, PCM and PCM/FM.

*Optional

Frequency response of 1.5 mc is obtained in the single-rack CM-100. A second auxiliary rack houses a demodulator, an oscilloscope monitor unit, and Mincom's new and exclusive Tracklok.

Mincom Division 3M MINNESOTA MINING & MANUFACTURING CO.

2049 SO. BARRINGTON AVE., LOS ANGELES 25, CALIFORNIA • 529 PENN BLDG., 425 13th ST. N.W., WASHINGTON 4, D.C.



the simple approach to low noise

GALLIUM ANTIMONIDE TUNNEL DIODE AMPLIFIERS: Stable, high gain GaSb Tunnel Diode Amplifiers with noise figures from 2.5 to 3.5 db are now available. These units cover frequency ranges from 125 to 1400 mc with bandwidths to 6%. Octave bandwidth units are also available. The over-all quality of these amplifiers is a direct result of Micro State's creative capability and integrated design approach.

Circle 11 on Inquiry Card

FROM BASIC MATERIAL — TO SEMICONDUCTOR DEVICE — TO MICROWAVE COMPONENT

micro state electronics corporation

152 FLORAL AVENUE, MURRAY HILL, NEW JERSEY CR 7-6600

GALLIUM ARSENIDE MATERIAL • GERMANIUM TUNNEL DIODES

SOLID STATE UHF AND MICROWAVE AMPLIFIERS AND OSCILLATORS • GALLIUM ARSENIDE VARACTORS

GaSb TUNNEL DIODES: These diodes have cutoff frequencies up to 4 KMC. Shot noise constants as low as 0.7, compared to 1.3 for germanium, permit the construction of tunnel diode amplifiers with parametric noise figures.

GaSb MATERIAL: Single crystal GaSb is offered for device applications. Undoped material, and tellurium, or zinc doped GaSb is available for the fabrication of low noise tunnel diodes.

News Briefs

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

EAST

CBS LABORATORIES, Stamford, Conn., and **GULTON INDUSTRIES, INC.,** Metuchen, N. J., have completed arrangements whereby CBS Labs has granted world-wide rights for the manufacture and marketing of a pocket-sized, rechargeable dictating device to Gulton Industries.

FREQUENCY STANDARDS, Asbury Park, N. J., has changed its name to **FREQUENCY ENGINEERING LABORATORIES.**

SPRAGUE ELECTRIC CO., North Adams, Mass., has purchased all the equipment previously used by CBS Electronics for the manufacture of electro-chemical precision-etch transistors. The purchase included fast automatic semiconductor transfer lines and testing equipment for manufacturing MADT and MAT transistors.

LFE ELECTRONICS, DIV. LABORATORY FOR ELECTRONICS, INC., Boston, Mass., has been awarded two contracts by the U. S. Air Force totalling approximately $1.8 million. Contracts call for ground support equipment for flight line checkout of the AN/APN-131 self-contained, airborne Doppler navigation systems.

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

JERROLD ELECTRONICS CORP., Philadelphia, Pa., has acquired **TECHNICAL APPLIANCE CORP.** (Taco), Sherburne, N. Y., through purchase of its assets for $2,700,000.

GENERAL INSTRUMENT CORP., HARRIS ANTI-SUBMARINE WARFARE DIV., Woodbury, Conn., has received a $2,002,206 United States Navy contract for the manufacture of sonar transducers used in long-range underwater detection systems.

MAXSON ELECTRONICS CO., New York, N. Y., has acquired **HOPKINS ENGINEERING CO.,** San Fernando, Calif., for an undisclosed amount of Maxson stock, and will operate Hopkins as a wholly-owned subsidiary of Maxson Electronics Corp.

MELPAR, INC., SPECIAL PRODUCTS DIV., is opening new plant production facilities in Arlington, Va. to produce plastic sheeting for acoustical damping in Navy ships, in consequence of an award of $83,000 by the Military Industrial Supply Agency in Philadelphia, Pa.

BURNELL & CO., INC., Pelham, N. Y., has acquired 80% of the common stock of **GLP ELECTRONICS, INC.,** Bristol, Conn. GLP will operate as a subsidiary of Burnell & Co.

ALLIED CHEMICAL CORP., GENERAL CHEMICAL DIV., has moved its Technical Service Laboratory to new headquarters at the Company's Morris Township, N. J. Research Center. The new address is P. O. Box 405, Morristown, N. J.

AMPHENOL-BORG ELECTRONICS CORP., has dedicated a new plant at the Fair Lawn Industrial Park, N. J., part of its $4½ million expansion program. This is the first plant of the newly-created **AMPHENOL - EASTERN CONNECTOR DIV.,** and is for the design and production of wire connecting devices.

ADLER ELECTRONICS INC., New Rochelle, N. Y., has received a contract of over $600,000 for the production of high freq., SSB, dual diversity receivers, in the 2.8 to 28 mc freq.

GENERAL ELECTRIC CO.'s MISSILE AND SPACE VEHICLE DEPT., Phila., Pa., has received a $882,600 contract from the Air Force's Aeronautical Systems Div., to develop an aerospace test capsule for testing a 50 w fuel cell battery.

TELECHROME MFG. CORP., Amityville, N. Y., has received a U. S. Army Signal Corps award contract for $324,000 for 300 AN/URM-80 frequency meters.

RAYTHEON CO. has announced plans to expand its semiconductor operations and consolidate its silicon transistor, rectifier and Circuit-Pak activities at Lowell, Mass. The Semiconductor Div. will establish headquarters and other offices in the 204,000 sq. ft. former CBS Electronics plant.

MIDWEST

MIRATEL ELECTRONICS, INC., has added 10,000 sq. ft. of assembly work space to its New Brighton, Minn. plant.

CENTRALAB, ELECTRONICS DIV. GLOBE-UNION INC., has completed acquisition of **WILRITE PRODUCTS, INC.,** Cleveland, Ohio. Wilrite will operate as a wholly-owned subsidiary of Centralab.

SANGAMO ELECTRIC CO., Springfield, Ill., in keeping with their program of realignment and relocation of production facilities, is expanding their Pickens, So. Carolina plant by 65,000 sq. ft., transferring their capacitor production from Marion, Ill. to Pickens. It is also beginning construction of a 150,000 sq. ft. plant in Walhalla, S. C., for the manufacture of certain types of singlephase electric meters.

GOULD-NATIONAL BATTERIES, INC., St. Paul, Minn., has been awarded a contract by the U. S. Navy in excess of $2.5 million for submarine batteries.

The Board of Directors and stockholders of **MIDWEST FOAM PRODUCTS CO.,** Evanston, Ill., and the Board and stockholders of **SHELLEY URETHANE INDUSTRIES, INC.,** Los Angeles, Calif., have approved a plan of merger. The new corporation will be known as **URETHANE INDUSTRIES INTERNATIONAL, INC.,** with headquarters in Evanston, Ill.

COLLINS RADIO CO., TEXAS DIV., Dallas, Tex., has received a $4 million contract from the U. S. Army Signal Corps for an undisclosed number of portable scatter communication terminals, AN/TRC-80.

WEST

CONTINENTAL ELECTRONICS MFG. CO., SUB. OF LING-TEMCO-VOUGHT, INC., has received a $3 million contract to design a multi-megawatt radar transmitter for the Army's tactical NIKE-ZEUS antimissile system.

SYSTEM DEVELOPMENT CORP. has dedicated its $3 million Systems Simulation Research Laboratory at Santa Monica, Calif.

FAIRCHILD SEMICONDUCTOR CORP., has started construction on a new $1.5 Research and Development Center in Stanford Industrial Park, Palo Alto, Calif. The 65,000 sq. ft. building is located on Junipero Serra Blvd.

EITEL-McCULLOUGH, INC., San Carlos, Calif., has received a contract for $1,567,141 for the manufacture of 3CX100A5 power-grid electron tubes from Procurement Headquarters, Gentile U. S. Air Force Station, Dayton, Ohio.

AMPEX CORP., Redwood City, Calif., has received a $3,600,000 order from **PHILCO CORP.** for an undisclosed number of advanced memory devices.

HOFFMAN ELECTRONICS CORP., SEMICONDUCTOR DIV., El Monte, Calif., will consolidate all operations in its El Monte, Calif. plant. Fifty thousand additional sq. ft. of floor space will be devoted to manufacturing and reliability testing.

THE BENDIX CORP., North Hollywood, Calif., has been awarded a follow-on contract in excess of $5 million for helicopter-borne sonar systems from **SIKORSKY AIRCRAFT DIV., UNITED AIRCRAFT CORP.** The systems AN/AQS-10 "dunking sonar," will be installed in the Navy's HSS-2 all-weather anti-submarine helicopter.

ALFRED ELECTRONICS, Palo Alto, Calif., has completed their new 32,000 sq. ft. plant located at 3176 Porter Drive, Stanford Industrial Park.

DATA SENSORS, INC., Gardena, Calif., has been formed to engage in the research, development, engineering design and manufacture of electrical, electronic and electro-mechanical instruments used in the acquisition, conditioning and interpretation of data for military, space, and industrial programs. The company is located in a 10,000 sq. ft building at 13112 Crenshaw Blvd., Gardena, Calif.

DAYSTROM, INC., PACIFIC DIV., Los Angeles, Calif., has received follow-on orders totaling $170,000 for special gyroscopes for **AEROJET-GENERAL CORP.** sounding rockets.

HUGHES AIRCRAFT CO., SEMICONDUCTOR DIV., Newport Beach, Calif., has received a $125,000 study contract to investigate high freq. transistors and circuits from the U. S. Navy's Bureau of Ships.

TRANSDATA, INC., El Cajon, Calif., has received through the **TELE-TRONICS CO.,** an order from the Navy's BuShips for the manufacture of single sideband receivers AN/WRR-2( ) and AN/FRR-59( ). The contract is in excess of $1 million.

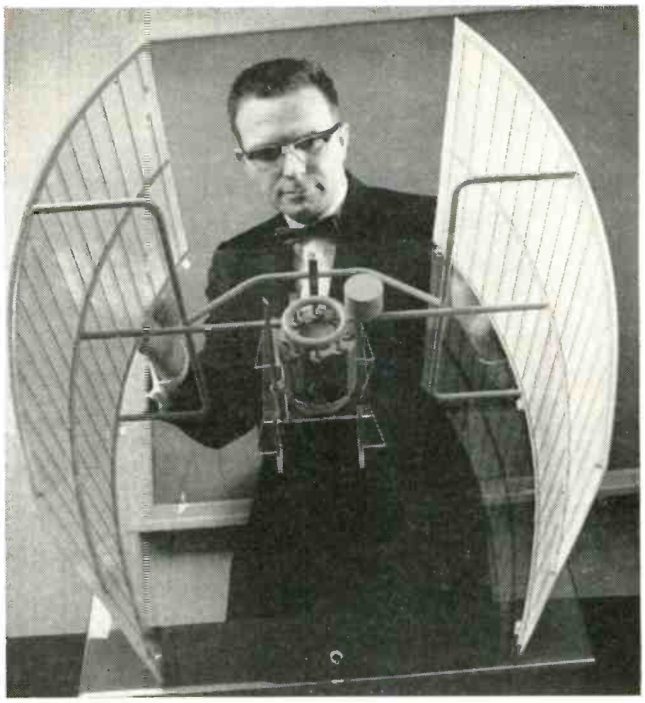
HEWLETT-PACKARD CO., Palo Alto, Calif., has formed a new affiliated company to engage in solid-state research and development. The new firm will be known as **HP ASSOCIATES** and will be headquartered in Palo Alto.

"AUTOBANKER"

Teller and customer of the First National Bank of Waukesha, Wis. can exchange conversation, cash and banking documents using Autobanker, designed by The Mosler Safe Co. and engineered by ITT Corp. Closed circuit television and pneumatic tubes allow customers to transact most of their banking business from their automobiles.

IMAGE INTENSIFIER ORTHICON

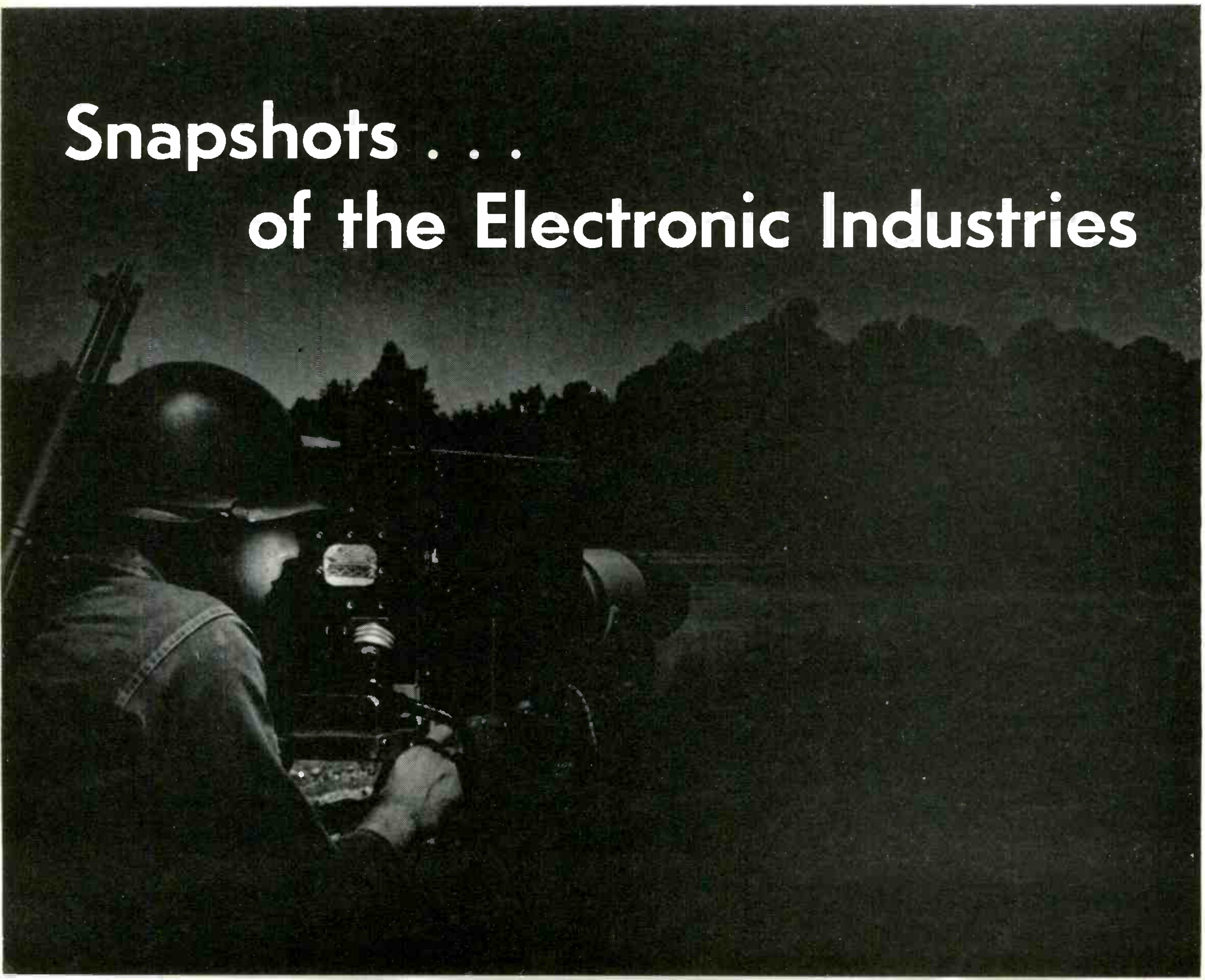
Specialist 5/c A. D. Porter focuses TV camera on "enemy" tank in the dark. Camera is equipped with special tube, developed by the Radio Corporation of America for the U.S. Army Engineers, which needs only starlight, moonlight or skyglow to operate. Diffused natural light reflected from the target is intensified to present an image.

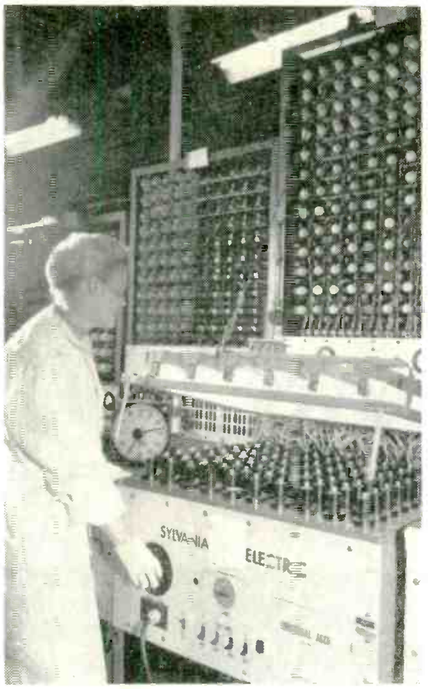


SPACE POWER SYSTEM

Niles F. Schuh, Westinghouse Electric section manager, is shown with a model of a nuclear thermoelectric power system for space, moon and other uses requiring long-lived, maintenance-free operation. System uses spontaneous decay of a radioisotope to produce heat which is converted to electricity by thermoelectric principles.

Snapshots . . . of the Electronic Industries





PHOTOCONDUCTOR TEST

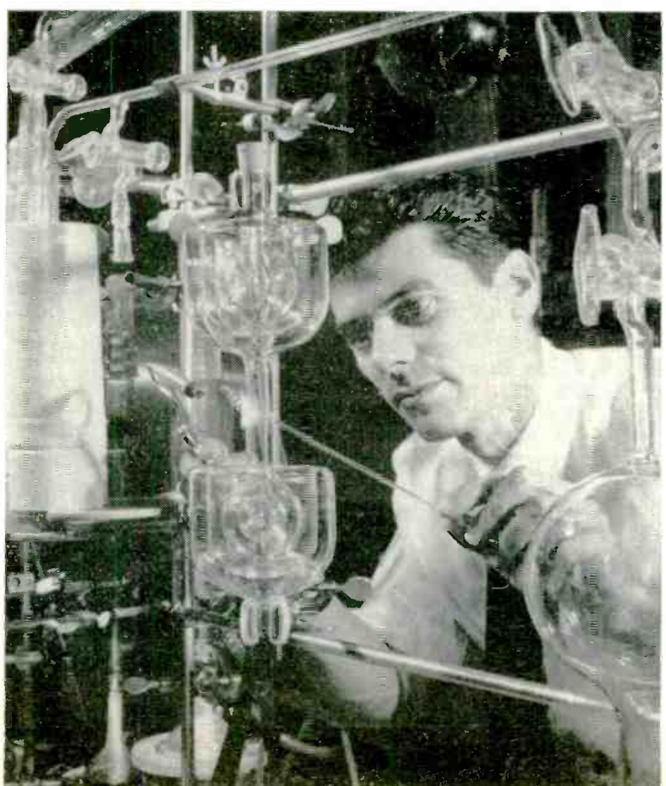
At headquarters of Sylvania's Electronic Tube Division, Emporium, Pa., hermetically sealed photoconductor devices are life-tested on company-designed aging equipment.

WORLD'S LARGEST

Workers platform is suspended from a 250 ft. crane over the world's largest radome on Haystack Hill, Tyngsboro, Mass. Constructed under direction of the USAF's Electronic Systems Div., it will house a sensitive radio communications and space research antenna.

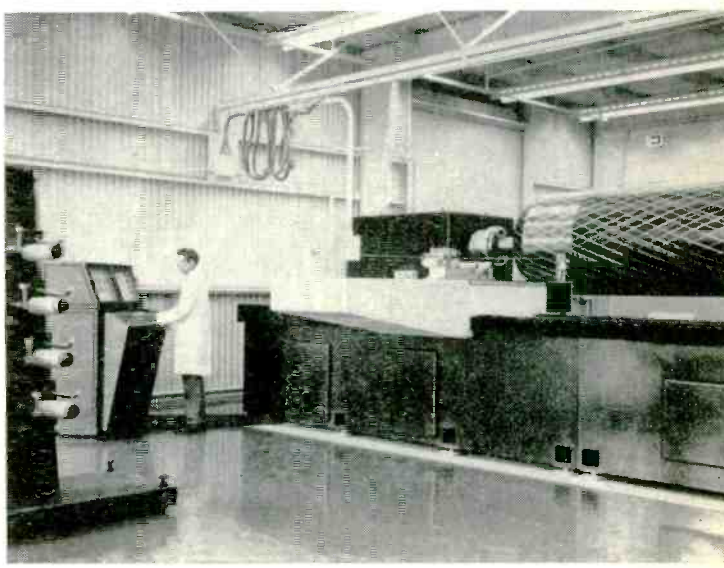
"SPACE VACUUM"

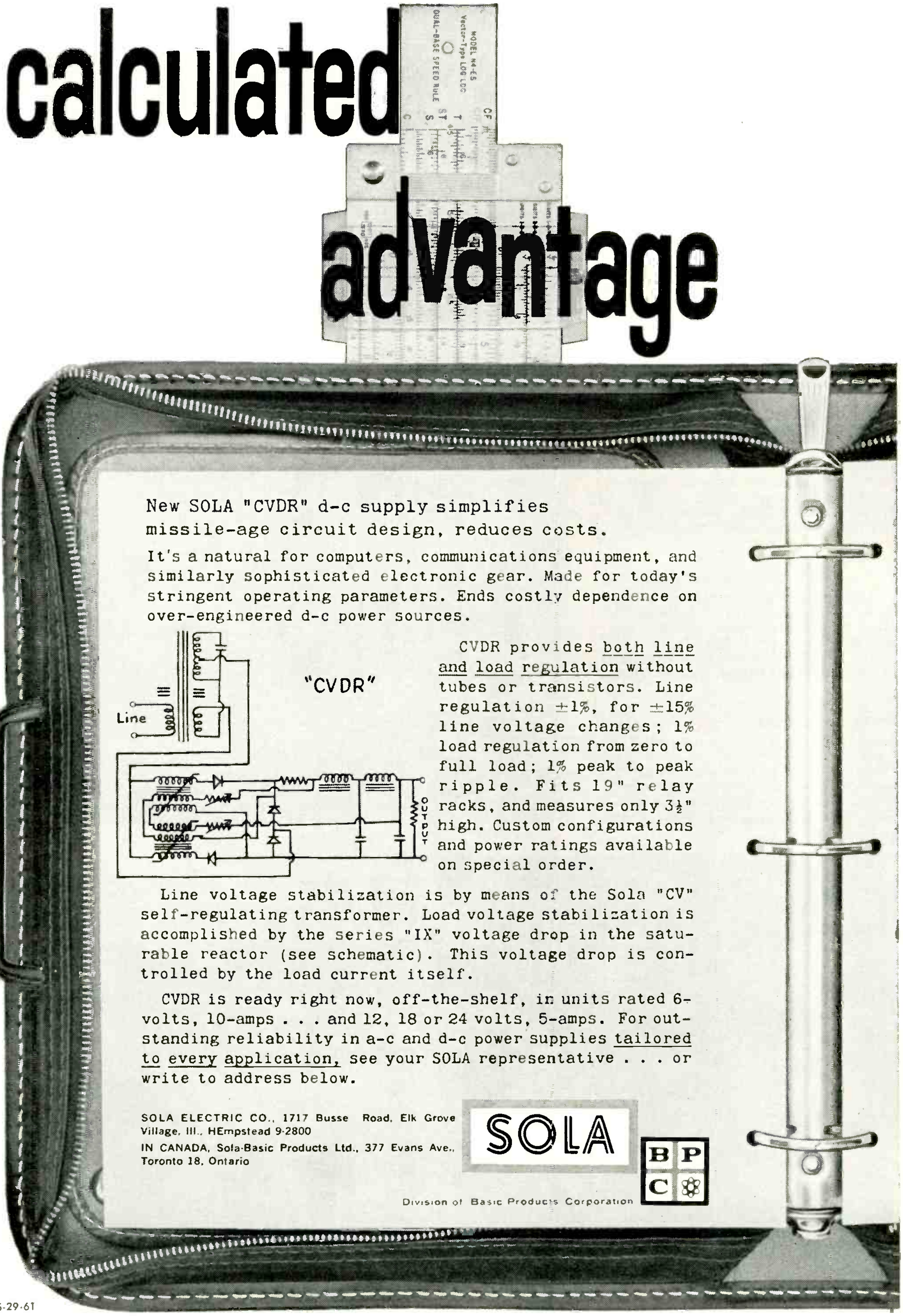
High efficiency, triple chamber cold traps, shown being fused together by G. R. Neff, Hughes Aircraft Co. researcher, will be filled with liquid nitrogen and used with mercury diffusion and ion pumping to produce vacuum (10-12mm Hg) required in space studies.



FILAMENT WINDING MACHINE

Machine will automatically manufacture wound fiberglass rocket engine cases and missile fuel tanks for advanced types of ballistic missiles. Machine is controlled by Thompson Ramo Wooldridge, Inc. (Michigan City, Indiana) all-transistorized numerical control system.

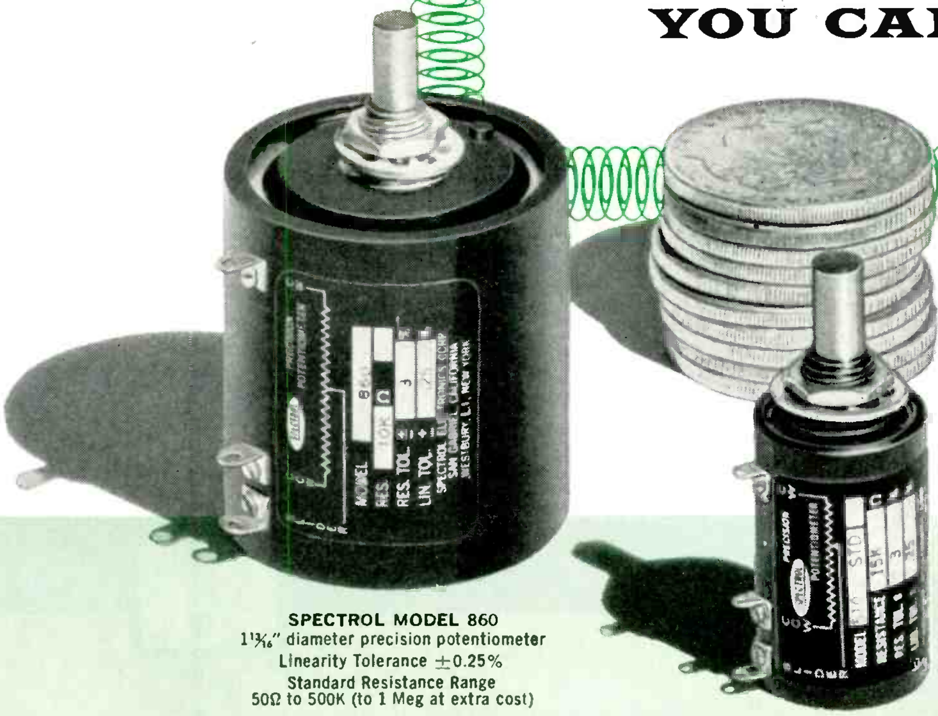



calculated advantage
New SOLA "CVDR" d-c supply simplifies missile-age circuit design, reduces costs.
It's a natural for computers, communications equipment, and similarly sophisticated electronic gear. Made for today's stringent operating parameters. Ends costly dependence on over-engineered d-c power sources.
"CVDR"
Line
OUTPUT
CVDR provides both line and load regulation without tubes or transistors. Line regulation ±1%, for ±15% line voltage changes; 1% load regulation from zero to full load; 1% peak to peak ripple. Fits 19" relay racks, and measures only 3½" high. Custom configurations and power ratings available on special order.
Line voltage stabilization is by means of the Sola "CV" self-regulating transformer. Load voltage stabilization is accomplished by the series "IX" voltage drop in the saturable reactor (see schematic). This voltage drop is controlled by the load current itself.
CVDR is ready right now, off-the-shelf, in units rated 6-volts, 10-amps . . . and 12, 18 or 24 volts, 5-amps. For outstanding reliability in a-c and d-c power supplies tailored to every application, see your SOLA representative . . . or write to address below.
SOLA ELECTRIC CO., 1717 Busse Road, Elk Grove Village, Ill., HEmpstead 9-2800
IN CANADA, Sola-Basic Products Ltd., 377 Evans Ave., Toronto 18, Ontario
SOLA
BP
C
Division of Basic Products Corporation

S-29-61

TEN

THE BEST $10 POTS YOU CAN BUY



Stocked by 50 Local Distributors Throughout the U.S. and Canada for Immediate Off-the-Shelf Delivery

SPECTROL MODEL 860
1¹³⁄₁₆" diameter precision potentiometer
Linearity Tolerance ±0.25%
Standard Resistance Range
50Ω to 500K (to 1 Meg at extra cost)

SPECTROL MODEL 510
⅞" diameter precision potentiometer
Linearity Tolerance ±0.25%
Standard Resistance Range
15Ω to 150K (to 250K at extra cost)

These two Spectrol 10-turn precision pots are *not* specials in any way. They're standard production items in two popular sizes, tailor-made to fit almost all 10-turn requirements. Here's where Spectrol excels to give you the best pot for your 10-spot:

END RESISTANCE Spectrol's low end resistance is achieved by tap welding terminations to the turn of resistance wire nearest the mechanical stop. In addition, Spectrol provides an extra turn of helical resistance element beyond the stop insuring electrical continuity under all conditions.

ROTOR MASS Spectrol's lightweight rotor reduces inertia and starting torque, as well as minimizing the effects of shock and vibration.

WIPER MASS A wiper that's the lightest we've seen in any 10-turn pot allows lower contact force with resultant long life and superior performance under shock and vibration.

SHAFT SUPPORT Spectrol pot shafts are supported by bearings at both ends and have provision for rear shaft extension.

STOPS Spectrol uses 750 oz. in. stops on Model 860; 50 oz. in. on Model 510, the strongest you'll find.

LIDS SECURED BY INTERNAL SNAP RING Use of snap rings gives 360° lid support as opposed to other methods of attachment. Another exclusive feature: Remove or replace lids without damaging unit.

POWER RATING Model 860, 8 watts, and Model 510, 3 watts; at 40° C ambient.

SPECIAL FEATURES AVAILABLE
Additional taps up to 111 on Model 860; up to 49 on Model 510. Special front shaft configurations and rear extensions. Special linearity and resistance tolerances.

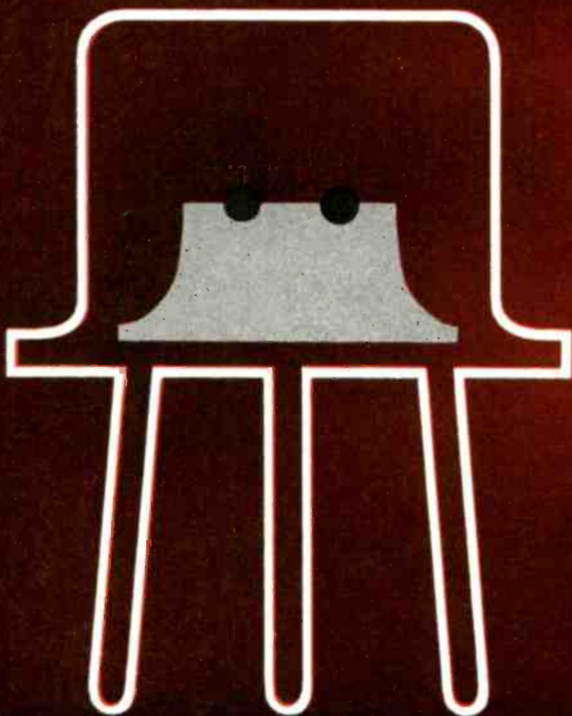
More Data Available For complete electrical and mechanical specifications, and quantity discounts, contact your Spectrol representative or call or write the factory.

SPECTROL ELECTRONICS CORPORATION

1704 South Del Mar Ave. • San Gabriel, Calif. • Phone: ATlantic 7-9761
Adams Court • Plainview, Long Island, N.Y. • Phone: WEIls 8-4000
P.O. Box 130 • Brampton, Ontario, Canada

The World's Broadest Line of Precision Potentiometers

PHILCO EPITAXIAL SILICON MESA



FIRST TO COMBINE
120 V (BV_{CBO})
0.5 V(*SAT*)
150 mc. f_T

2N2087 NPN
CORE DRIVER
LINE DRIVER

TO-5

2N2087; ABSOLUTE MAXIMUM RATINGS

Storage Temperature .... −65 to +300°C.
BV_{CER} ($R \leqq 10\Omega$) .... 80 volts
BV_{CBO} .... 120 volts
BV_{EBO} .... 5 volts
Collector Current I_C .... 500 ma
Total Device Dissipation (case 25°C.) .... 2 watts
Total Device Dissipation (case 100°C.) ... 1 watt
Total Device Dissipation (free air 25°C.) . 0.6 watt

ELECTRICAL CHARACTERISTICS (@ 25°C.)

Characteristics	Conditions	Min.	Max.	
h_{FE}	$V_{CE} = 1V.$ $I_C = 150$ ma.	40	120	
V_{BE}	$I_C = 150$ ma. $I_B = 15$ ma.		1.2	volts
V_{CE}(SAT)	$I_C = 150$ ma. $I_B = 15$ ma.		0.5	volts
f_T	$I_C = 50$ ma. $V_{CE} = 10V.$	150		mc
C_{ob}	$V_{CB} = 10V.$ $I_E = 0$ ma.		12	pf
I_{CBO}	$V_C = 60V.$ $T = 25°C.$		2	μa
I_{CBO}	$V_C = 60V.$		150	μa
BV_{CER}	$R \leqq 10\Omega$ $I_C = 20$ ma. pulsed	80		volts
t_r			85	nsec
t_s			100	nsec
t_f			55	nsec

You would expect Philco, as inventor of industry's most capable germanium logic transistor—the MADT, to design silicon memory components with extra capability, too. And Philco has done it. 2N2087 and 2N2086 Philco epitaxial silicon mesa transistors offer incomparable combinations of parameters that may well be the special design solutions you require.

The 2N2087 combines 120 BV_{CBO}, 40 h_{FE} min., 0.5 V. max. V_{CE} (SAT), 150 mc min. f_T, 12 pf max. C_{ob}, and 100 nsec max. t_s.

The 2N2086 combines h_{FE} of 20 min., 0.7 max. V_{CE} (SAT), 120 BV_{CBO}, 150 mc min. f_T, 12 pf max. C_{ob}, and 100 nsec max. t_s.

These new Philco epitaxial silicon mesa transistors deliver optimum drive for computer memory planes, serve as medium power switches in airborne control systems, and are ideally suited to a wide variety of other applications such as small power supplies, servo amplifiers, and automation controls. For complete information, write Dept. EI1161.

Both types 2N2087 and 2N2086 are immediately available from your Philco Industrial Semiconductor Distributor.

Circle 18 on Inquiry Card

PHILCO®

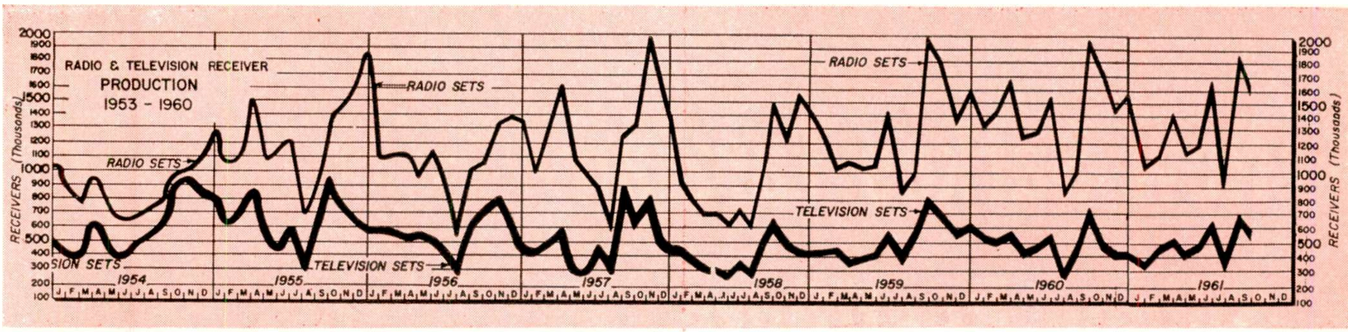
Famous for Quality the World Over

LANSDALE DIVISION, LANSDALE, PENNSYLVANIA

TRANSISTOR CENTER U.S.A.®

Facts and Figures Round-Up November 1961

ELECTRONIC INDUSTRIES TOTALS



GOVERNMENT ELECTRONIC CONTRACT AWARDS

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

Alarm set	49,765
Amplifiers	1,173,512
Analyzers	192,182
Antenna	742,877
Batteries	171,777
Beacon array	75,000
Cable assembly	835,979
Capacitor	66,768
Coders	823,146
Communications equipment	1,404,281
Computers	863,705
Connectors	55,329
Coupler, directional	30,880
Direction finders	186,237
Filter	25,326
Fuses	29,428
Indicators	66,333
Intercom equipment	69,778
Meters	48,901
Monitor, signal data	247,961
Multicouplers	214,481
Oscillographs	43,154
Oscilloscopes	239,847
Recorders/Reproducers	1,649,061
Relay armature	172,957
Relays	124,961
Resistors	28,019
Signal generators	31,680
Spectrum analyzer	36,502
Switch	239,431
Synchros	134,550
Systems	3,727,011
Telemetering equipment	155,699
Test equipment	4,465,291
Test sets	540,682
Towers	333,800
Transceivers	190,800
Transformer set	109,246
Transmitters	328,148
Transistors	27,215
Tube, electron	6,776,405
Tube, klystron	123,000
Tube, magnetron	2,802,261

NASA Expenditures for R&D-1953 to Date (Millions of Dollars)

Year Ending June 30	Total	Conduct of R & D	Increase in R & D Plant
1953	$78.6	$49.5	$29.1
1954	89.5	47.6	41.9
1955	73.8	43.4	30.4
1956	71.1	50.5	20.6
1957	76.0	55.2	20.8
1958	89.2	72.0	17.2
1959	145.5	114.7	30.8
1960	401.0	346.7	54.3
1961[E]	770.0	678.0	92.0
1962[E]	965.0	834.0	131.0

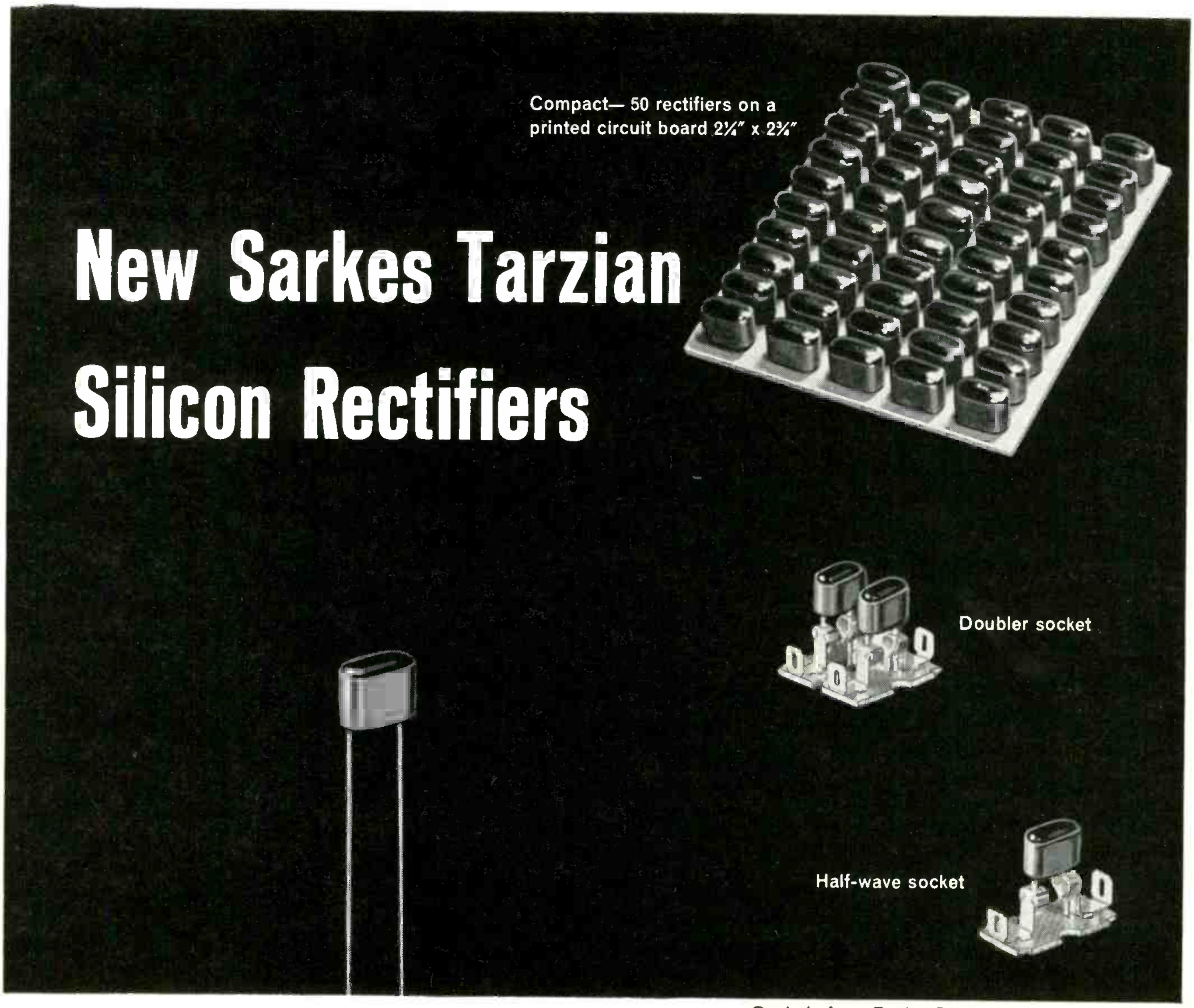
[E] Estimate.

Source: Executive Office of the President, Bureau of the Budget, Estimate Division, "Budget of the U. S. Govt." (Annual).

United Kingdom: Domestic Exports of Electronic Products to the United States, 1957-1960

Product	Quantity in thousands of units				Value in thousands of dollars[1]			
	1957	1958	1959	1960	1957	1958	1959	1960
TOTAL	....	....	....	....	12,831	17,184	21,974	19,645
Radio receivers, complete	10.9	4.4	9.7	7.5	232	135	292	200
Radio phonographs, complete	0.9	3.6	2.4	2.0	115	304	232	190
Speakers and microphones	....	....	....	....	285	479	532	699
Phonographs, electronic, and record players	3.9	4.6	4.7	19.6	160	160	147	362
Phonograph parts and accessories	....	....	....	....	935	904	1,207	727
Record playing mechanisms:								
With record changer	699.8	926.3	1,251.7	861.1	6,816	8,678	11,739	7,920
Without record changer	12.9	125.2	102.2	38.3	133	520	623	219
Electronic and nucleonic valves and tubes[2]:								
Complete	3,308.5	5,375.7	4,591.0	4,558.5	1,345	2,303	2,381	2,501
Parts	....	....	....	....	(x)	10	97	306
Components and parts	....	....	....	....	952	1,221	1,243	1,458
Communications, navigation, and radar equipment	....	....	....	....	1,014	1,388	2,178	2,813
Other electronic products	....	....	....	....	844	1,082	1,303	2,250

[1] Value figures converted from pounds sterling to U. S. dollar equivalents at the rate of £=$2.80.
[2] Includes transistors.
[3] Less than $500.
Source: Data compiled by the British Radio Equipment Manufacturers' Association from Statistics of H.M. Customs and Excise.



Sockets from Fastex Division, Illinois Tool Works

for plug-in sockets and printed circuits

This new series of silicon rectifiers is especially suited for use in printed circuit assemblies, or can be plugged directly into special sockets to facilitate assembly and servicing. Insulated case —11/32″ x 3/16″ x 1/4″ high—eliminates many mounting problems. Leads are on 7/32″ centers.

Reliability is excellent—in part because the construction minimizes axial strain on the junction. Special Tarzian oversize junctions increase inrush current protection, contribute to low voltage loss, and lengthen useful life in this as in other Tarzian silicon devices. Prices are realistic.

Complete line catalog available. Application engineering assistance is also available without obligation. Send for data sheet.

Tarzian Type	Amps DC (85°C)	PIV	Maximum RMS Volts	Maximum Recurrent Peak	Amps Surge (4MS)
12	.75	200	140	7.5	75
14	.75	400	280	7.5	75
16	.75	600	420	7.5	75

SARKES TARZIAN, INC.

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

SEMICONDUCTOR DIVISION • BLOOMINGTON, INDIANA

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

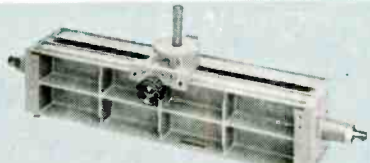
TESTED *waveguide and coaxial equipment*

752 Multi-Hole Coupler

Precision directional couplers provide coupling factors of 3, 10 or 20 db. Coupling accuracy ± 0.4 db or 0.7 db. Directivity better than 40 db full range, SWR less than 1:1 (752A), 1:05 (752C/D). Cover frequencies 2.6 to 40 GC. $100.00 to $375.00.

760D/761D Dual Directional Couplers

Ideal for reflectometer systems, these coaxial couplers are flat to ± 0.5 db over 4-to-1 frequency range. Directivity is 35 db (760D) and 30 db (761D). Feature high power capacity, low insertion loss and SWR. 760D, 250 MC to 1 GC, $200.00; 761D, 1 to 4 GC, $185.00.

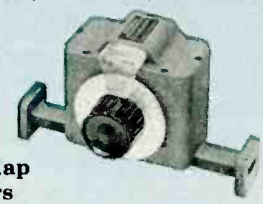


870A/872A Slide Screw Tuners

For waveguide, coaxial (872A shown) applications. Probe position, penetration sets up reflection cancelling existing reflection. Lead screw or micrometer varies probe insertion for 870A Tuners, 2.6 to 40 GC, $125.00 to $300.00. Micrometer drive varies insertion on 872A, 500 MC to 4 GC, $525.00.

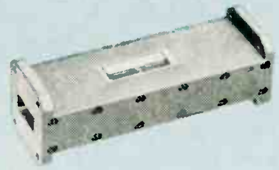
372 Precision Attenuators

Rugged, broadband fixed attenuators retaining precise calibration regardless of humidity, temperature or time. Invariant attenuation assured by permanent, "multi-hole coupler" joining of two waveguides. 10 and 20 db models, 2.6 to 18.0 GC. $110.00 to $400.00.



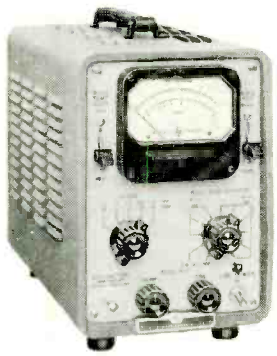
375A Variable Flap Attenuators

Simple, convenient for adjusting waveguide power or isolating source and load. Max. SWR less than 1.15 full range; attenuation variable 0 to 20 db, dissipates average powers up to 0.5 or 1 watt. S through R bands, 2.6 to 40.0 GC. $90.00 to $190.00.



362A Low Pass Filter

Compact models increase SWR measurement accuracy by suppressing harmonics; feature low insertion loss, broad stop band. 8.2 to 40.0 GC (includes N-band model). $325.00 to $385.00.



430C Microwave Power Meter
476A/477B/485 Mounts

430C reads rf power direct in dbm or mw, requires no calculations. Covers 2.6 to 40.0 GC, operates with 476A, 477B, 485 bolometer, thermistor or detector mounts; also with 487 Broadband Waveguide Thermistor Mounts (see alongside). 430C, (cabinet), $250.00; 430CR, (rack mount), $255.00. *476A Universal Bolometer Mount,* 10 to 1,000 MC without tuning, $85.00. *477B Coaxial Thermistor Mount,* 10 MC to 10 GC without tuning, $75.00. *485 Detector Mounts* available in three basic series: S485A 2.60 to 3.95 GC, no tuning; 485B, 3.95 to 12.4 GC; 485D, 2.6 to 8.2 GC. 485 models, $75.00 to $185.00.

487 Waveguide Thermistor Mounts

Models covering 2.6 to 40.0 GC. Each covers full range of guide; no tuning, SWR 1.35 to 2.0. 10 mw max power. Uses permanently installed 100 ohm negative coefficient thermistor; 18.0 to 40 GC models use 200 ohm thermistor. $75.00 to $225.00.

810/815B Slotted Sections

810B Slotted Sections. 810B, for 809B carriage, flanged, waveguide section with accurately machined slot. Slot tapered at ends to minimize reflection. 3.95 to 18.0 GC. $90.00 to $125.00.

S810A. Complete slotted section assembly including probe carriage. In 2.6 to 3.95 GC (S-band) size only. $450.00.

815B Slotted Sections. For mounting in 814B carriage. Available in two bands, 18.0 to 40.0 GC. Accurately machined; easy interchange, precise positioning. $265.00.

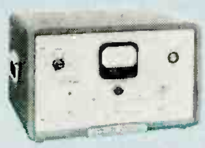
806B Coaxial Slotted Section. 3 - 12 GC, fits 809B, Type N connectors. $200.00.

805C/D Slotted Lines

Utmost mechanical rigidity, less leakage, greater accuracy, SWR 1.02 or 1.04. Range 500 MC to 4 GC, reads in cm and mm to 0.1 mm. 805C, for 50 ohm Type N, 805B, for 46.3 ohm RG 44/U. 805C, $525.00; 805D, $600.00.

415B/C Standing Wave Indicators

415B operates with all waveguide and coaxial slotted sections, gives readings in SWR or db. Low noise level, 0.1 μv full scale sensitivity, 60 db calib. attenuator. $200.00 (cabinet), $205.00 (rack). *New 415C* (pictured) offers similar characteristics but is transistorized, incorporates revolutionary four-times expansion of readings at any point on any scale. Price on request.



416A Ratio Meter

Displays ratio between two signals, irrespective of common amplitude variations. Especially useful for swept frequency measurement of VSWR, reflection coefficient, gain, insertion loss and other microwave parameters. Calibrated in VSWR, % reflection, db. See offer for Application Note 42 elsewhere in this advertisement. $550.00 (cabinet), $535.00 (rack).

HEWLETT-PACKARD COMPANY

1074B Page Mill Road — Palo Alto, California, U.S.A.
Cable "HEWPACK" — DAvenport 6-7000

Field representatives in all principal areas

HEWLETT-PACKARD S. A.

Rue du Vieux Billard No. 1 — Geneva, Switzerland
Cable "HEWPACKSA" — Tel. No. (022) 26. 43. 36

EI's International News

World Markets for Microwave Developments

Information supplied by the U.S. Chamber of Commerce indicates that a considerable interest is underway in the development of better communication services all over the world.

For the benefit of our readers we have condensed the pertinent data in a brief run-down of the present markets, and indicated where the best potential lies for U.S. manufactured products.

Australia

Australia is handicapped by duties for U.S. products. In spite of this there are several marketing possibilities. All government-ordered equipment which is unobtainable locally is duty free. The field covers electric test equipment, VHF radio. teletype equipment, and surveillance radar of simple design. The major customer will be the government.

Nepal

Nepal is considering the use of protected microwave links for internal telephone communications to replace the existing lines which are persistently stolen by the local hill people.

Netherlands

In the Netherlands the communications systems are practically complete, as the Parliament is considering the establishment of commercial television. No authority is yet established to proceed with this project.

Norway

The Norwegian government is considering a nation-wide microwave radio relay network consisting of 60 relay stations and one television channel or 960 telephone channels, all to be completed before 1965.

Portugal

A substantial expansion is under way in Portugal. At present, microwave is only used by the government communications. The Ministry of Defense has a long range plan for the gradual shift of VHF and UHF equipment and several new television projects are planned.

Rhodesia and Nyasaland

Rhodesian Television plans to set up its first station in Northern Rhodesia before December, 1961. Federal Ministry of Postal and Telegraphs plans to install 2.8 million dollars worth of forward scatter equipment to be supplied by a consortium of British firms. The best potential customer for U.S. equipment is the Department of Civil Aviation for long range radar, and HF forward scatter equipment. The Federation Airline and Central African Airways uses modern communications equipment.

Saudi Arabia

After the exploitation of the vast oil resources of Saudi Arabia, the economy has risen greatly. There are maintenance problems for radio communications equipment in the vast desert wastes. In addition, technicians do not relish, even with high salaries, the heat of the climate. However, specific plans have been made to improve communications by broadcasting and dial telephones, and for jet aircraft air-to-ground communications equipment. Other countries are contemplating this market. United States equipment is recognized and accepted. The major customer will be the Saudi Arabian government.

South Africa

Government Agencies comprise the largest market for radio communications equipment. The military contracts are already under exclusive rights to S. A. Phillips of the Netherlands. Certain equipment has been purchased by the government for two-way radio equipment for the South African police and it is likely that the Air Force would purchase U.S. equipment.

Switzerland

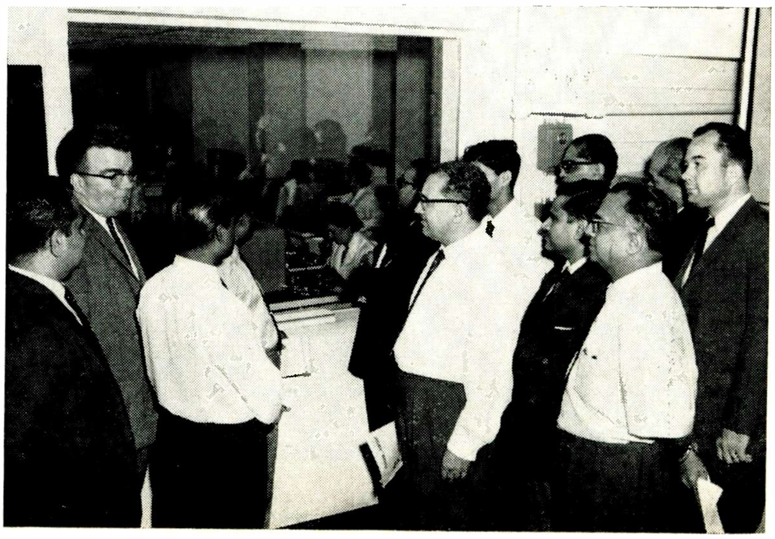
There is strong competition in Switzerland for communications equipment. However, U.S. airborne equipment is favorably accepted. It is likely that mobile radio communication can find a good United States market. It is recommended by the U.S. Consul in Switzerland that direct American representation would pay dividends for prospecting business in the various Swiss markets.

(*Continued on Page 34*)

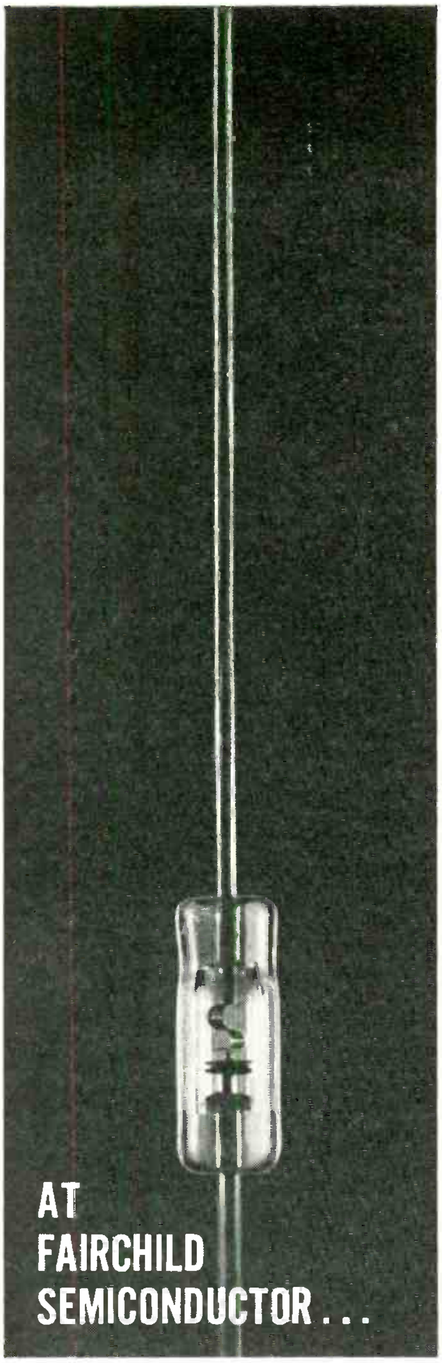
USA COMPANY LICENSES COMMON MARKET

Mr. Jack Goodman (center) Vice President of JFD Electronics Corp., Brooklyn, N. Y., announces the signing of a sales and license agreement between JFD's Components Div. and Le Condensateur Ceramigque (LCC) of Paris. The agreement covers six countries in the European Common Market.

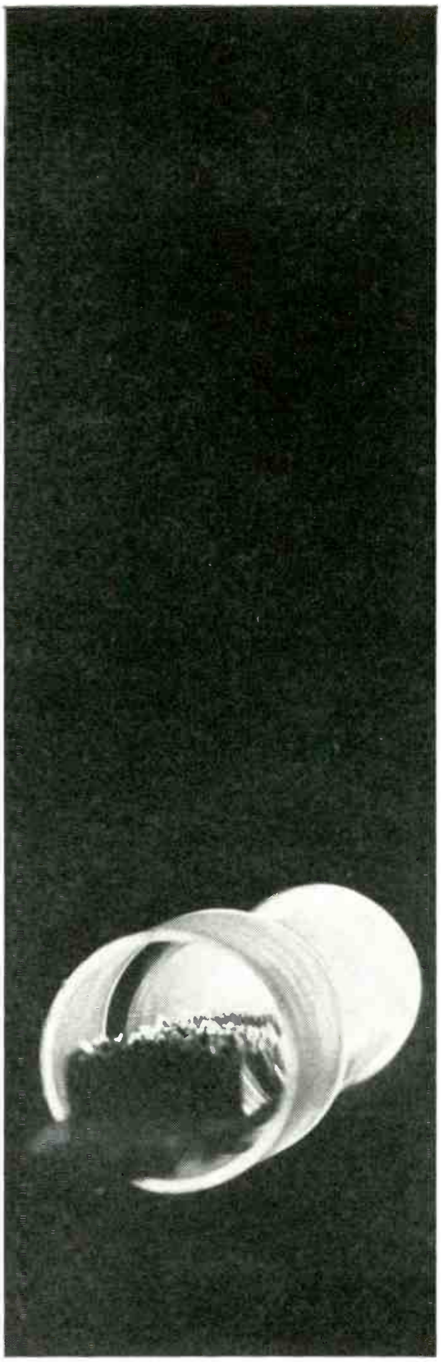
INDIAN DELEGATION VISITS USA



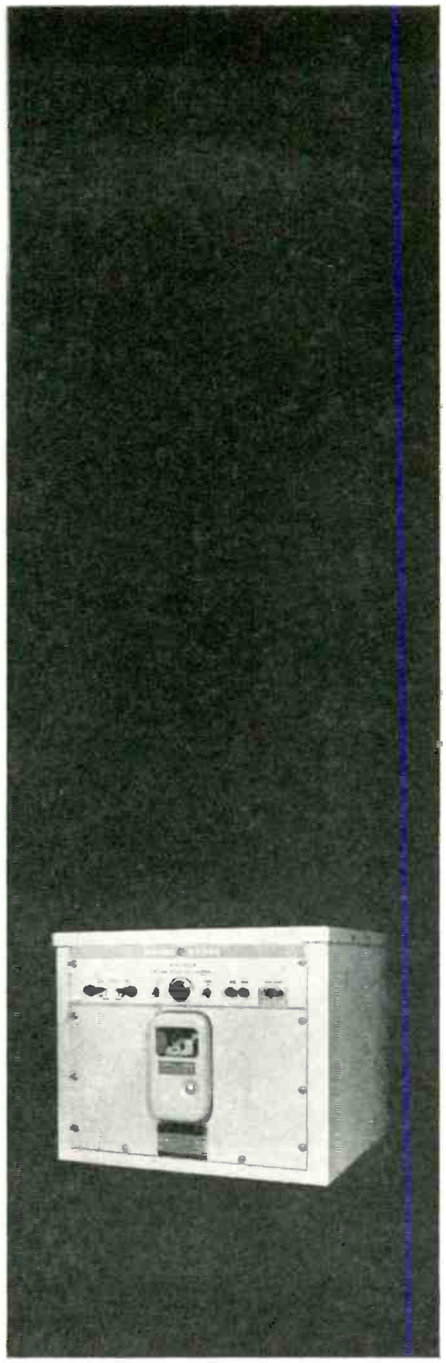
Members of the India Productivity Team paid a visit to Hickok Electrical Instrument Co., Cleveland, Ohio. Mr. J. W. Siringer, Advertising Manager, second from left, is explaining meter assembly operation in dust proof room.



THIS IS A
PRECISION PRODUCT . . .



THIS IS A
PRECISION PROCESS . . .



THIS IS
PRECISION VOLTAGE CONTROL BY G.E.

Thousands of minute potential transistors or diodes undergo diffusion simultaneously in this high-temperature electric furnace at the Fairchild Semiconductor diode plant in San Rafael, California. It's a *precision* process that demands *precision* voltage control. That's why Fairchild engineers specified General Electric Inductrol® voltage regulators for this and a number of other exacting manufacturing and testing operations.

Inductrol regulators may also be the ideal solution to *your* critical voltage problem. Operating on the inherently simple, inherently reliable, *induction* voltage regulation principle, Inductrol regulators can be used to hold fluctuating voltage to precise limits or, in other instances, to provide a variable voltage output from a relatively constant supply.

These advanced General Electric voltage regulators are available in three basic types—automatic, motor-driven, and hand-operated—and a wide range of ratings to meet your exact needs. Ask your G-E Sales Engineer for full information. Or write for Bulletin GEC-1450 to General Electric Company, Section 457-06, Schenectady 5, N. Y. *Voltage Regulator Products Section, Pittsfield, Mass.*

INDUCTROL REGULATOR FEATURES

- Reliable design and operation
- Automatic 1% control accuracy
- Stepless, drift-free controls
- 100% overload capacity up to one hour
- 97 to over 99% efficiency
- Load, power-factor and frequency compensated
- 25 X normal short-circuit capabilities
- No harmful waveform distortion
- Rugged, compact design

Progress Is Our Most Important Product

GENERAL ELECTRIC

Circle 19 on Inquiry Card

International News

MICROWAVE MARKETS

Kenya

There is a similar demand for radar in Kenya. A large expansion of the radio call service through the widely distributed population in rural areas is expected. Several agents are interested in representation of the U.S. HF equipment.

Angola

A six-year telecommunication project for $1.4 million is now under way for HF and VHF and UHF communications. The information about these plans may be obtained from the Ministry of Defense in Lisbon.

Hong Kong

A limited market exists in Hong Kong for United States manufactured retail and communication equipment. Two way radio systems are being used extensively and sales to the government and commercial operators are favorable.

West Germany

In West Germany almost all domestic radio and television stations and the Federal German Postal Authority are setting up new transmitters and relay stations.

Bermuda

Two-way radio systems have excellent prospects for government and commercial operators in Bermuda.

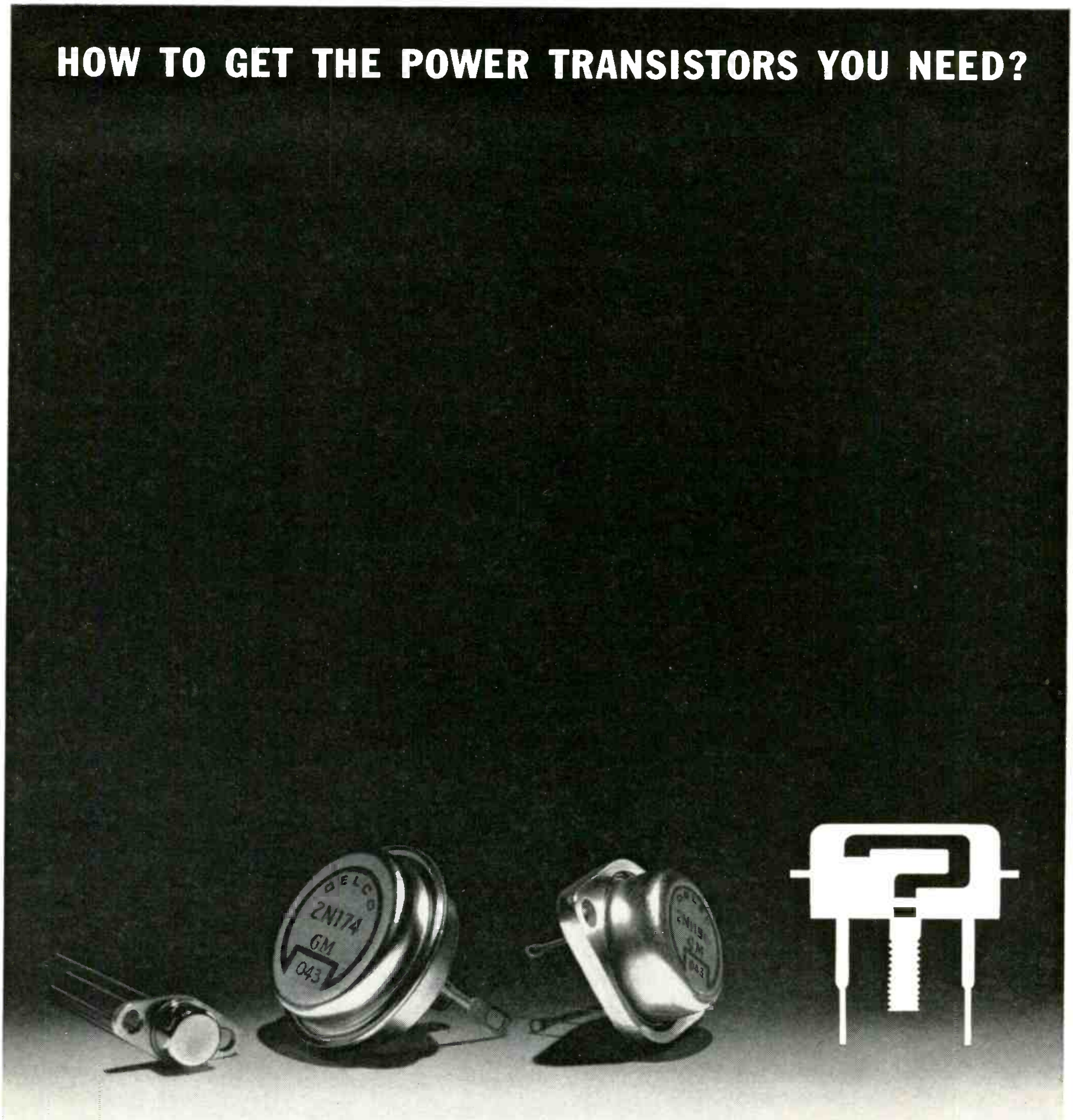
Mexico

In Mexico the industrial economy is rapidly rising because of the government's desire to promote development. There is a moderate potential for radio communications equipment; and the field at the moment is almost untouched.

Mozambique

In Mozambique the underdeveloped nature of the economy and industrial complex provides a similar opportunity as part of the Second Development Plan, which allocates approximately half million dollars for radio communications.

More News on Page 40



JUST ASK DELCO. For even though our catalog lists only a handful of germanium power transistors, there is only a handful out of all those ever catalogued that we don't make. And those only because nobody ever asked for them.

We've made, by the millions, both large and small power transistors. Both diamond and round base. Both industrial and military types. And each in a wide variety of parameters that have proved themselves reliable in nearly every conceivable application.

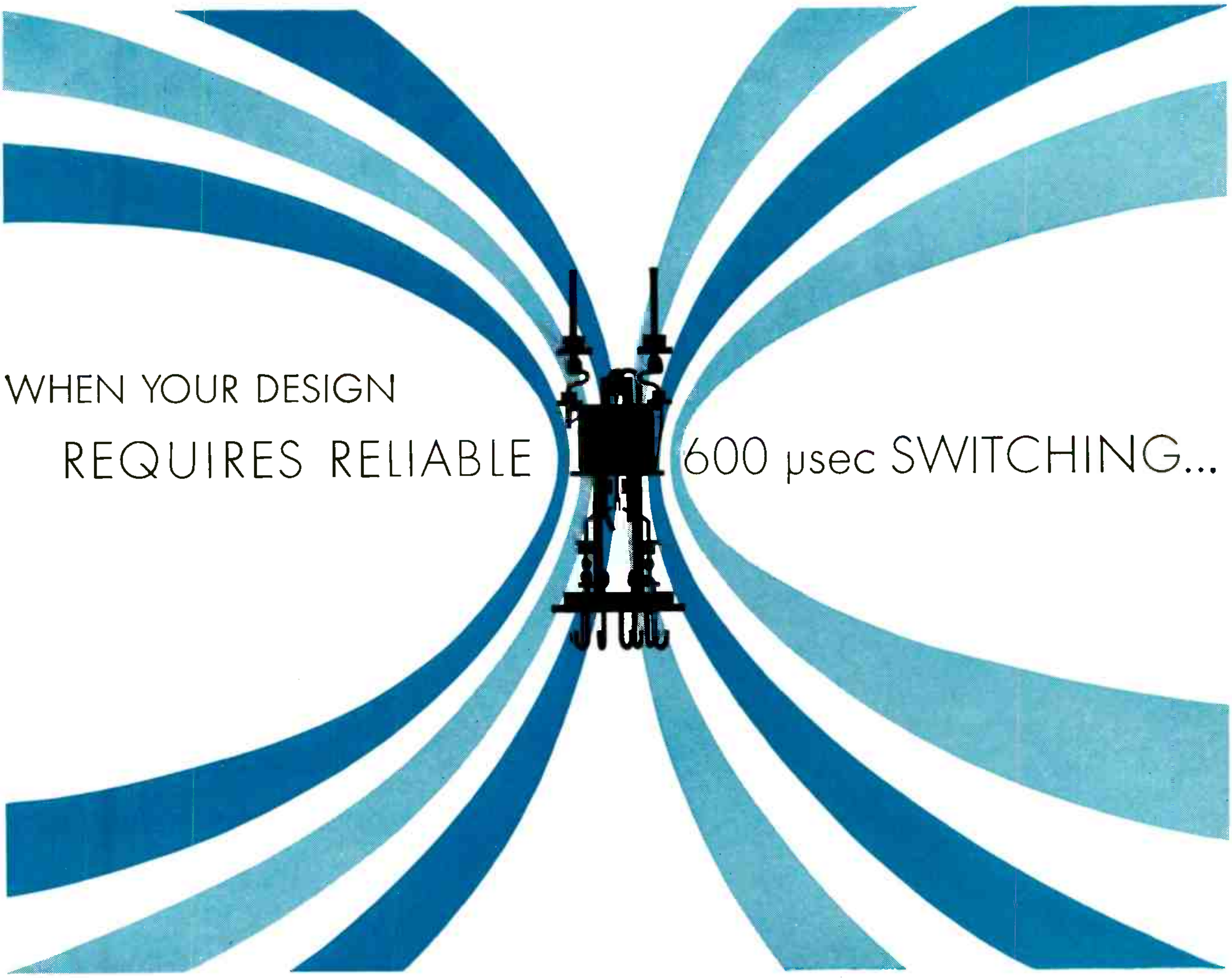
You get Delco transistors fast. You get Delco transistors in any quantity. And for all their high reliability, you get them reasonably priced. All you have to do is contact our nearest sales office—and ask for them.

Union, New Jersey 324 Chestnut Street MUrdock 7-3770	Santa Monica, California 726 Santa Monica Blvd. UPton 0-8807	Chicago, Illinois 5750 West 51st Street POrtsmouth 7-3500	Detroit, Michigan 57 Harper Avenue TRinty 3-6560	Syracuse, New York 1054 James Street GRanite 2-2668

DELCO RADIO
Dependability Reliability

Division of General Motors
Kokomo, Indiana

Practical Products for Creative Engineering



OAK HIGH SPEED RELAYS—

Oak engineers have spent years of research in designing this reliable high-speed relay. When used in computer, multiplexing, or telemetering applications, this SPDT, break-before-make relay will provide combined pull-in and drop-out times ranging from 600 to 1000 micro-seconds. Most important, however, is the care taken in design and manufacture to assure minimum life of 5 X 10^8 operations over specified environmental conditions. This care extends not only to the design and the selection of materials but also includes accurate assembly in the new Oak Relay White Room to assure performance to these rigid specifications. For complete specifications, contact your local Oak sales representative.

AMBIENT TEMPERATURES: −55°C to +100°C, operating; −65°C to +100°C, storage
VIBRATION: 5 to 500 cps, 10G, per Method 204, MIL-STD-202A
SHOCK: 15 G for 11 ± 1 millisec
ALTITUDE: 50,000 ft. per Method 105, MIL-STD-202A
CORROSION: 50-hr salt spray per Method 101A, MIL-STD-202A
HUMIDITY: Method 196, MIL-STD-202A
CONTACT RATING: 1 ma max, 35 VDC
BOUNCE: 100 microseconds max
NOISE: Less than 100 microvolts, peak-to-peak, when tested according to EIA Standards Proposal No. 701

Creative Engineering • Quality Components

OAK MANUFACTURING CO.

CRYSTAL LAKE, ILLINOIS • *Telephone: Crystal Lake, 459-5000*

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APPLIANCE CONTROLS • ROTARY SOLENOIDS • CHOPPERS • CONTROL ASSEMBLIES

Circle 92 on Inquiry Card

The First Major Variable Resistor

In load life, freedom from resistance change under mechanical wear and aging, Stackpole Controls with new STABILITE* Elements surpass any general purpose variable resistors produced since the early days of radio!

By achieving far greater variable resistor stability—at no increase in cost—the new Stackpole STABILITE elements provide greater circuit design freedom while assuring maximum dependability for the equipment in which they are used.

Available in all Stackpole Control

*Trademark, Stackpole Carbon Co.

Advance in STABILITY in Years

types, STABILITE elements handle higher loads with an absolute minimum of derating. And they maintain their tolerance through years of hard use!

STABILITE elements result from entirely new techniques in applying carbon dispersions to a specially-developed base material. The accompanying data tells its own story of truly remarkable performance under pertinent conditions of normal use.

For complete details and engineering samples, call your local Stackpole sales engineer or write on company letterhead to: Electronic Components Division, Stackpole Carbon Company, St. Marys, Pennsylvania.

STACKPOLE

VARIABLE composition RESISTORS

Fixed Composition Resistors • Slide & Snap Switches • Ceramag® Ferrite Cores • Fixed Composition Capacitors • Ceramagnet® Ceramic Magnets • Electrical Contacts • Brushes for all Rotating Electrical Equipment • Graphite Bearings, Seal Rings, Anodes Hundreds of Related Carbon & Graphite Products

Compare this performance with any controls you've ever used before!

PERFORMANCE TEST

LOAD LIFE @ 25°C, 1000 hours
500 volts, dc. . . . . ¾ to 1 watt } depending on value.
750 volts, dc. . . . . ½ watt, Min.

LOAD LIFE @ 70°C, 1000 hours
500 volts, dc. . . . . ½ to ¾ watt } depending on value.
750 volts, dc. . . . . ½ watt, Min.

SHELF LIFE . . . . Unlimited

NOISE . . . . 3 to 8 millivolts, values below 500,000 ohms.
8 to 12 millivolts, values above 500,000 ohms.

Average Percent Resistance Change

ZERO LOAD @ 100°C for 1000 hours
±4%, values to 100k; ±2%, values above 100k.

VOLTAGE COEFFICIENT
Less than ±0.01% per volt. (±0.005% per volt, avg.)

TEMPERATURE CHARACTERISTIC
±3% from 20°C to 105°C

HUMIDITY: 95% RH @ 40°C for 240 hours
±4% to ±5%, values to 250k; ±6% to ±9%, values above 250k.

MECHANICAL LIFE: 25,000 cycles. . . . Less than ±4%

Control "Mechanics" Have Been Improved Too!

- **New rear bearings assure wobble-free shaft operation.**
- **70% less backlash on "ordinary" tandem controls. Zero backlash on tandems for stereo.**
- **Close-tracking or matched element controls available for stereo.**
- **Full line of switches for most types—rotary, push-push, pull-push.**
- **Built-in solder flux guards on switches of miniature, ⅝" diameter types.**

Circle 24 on Inquiry Card

Ballistic Camera Synchronization System

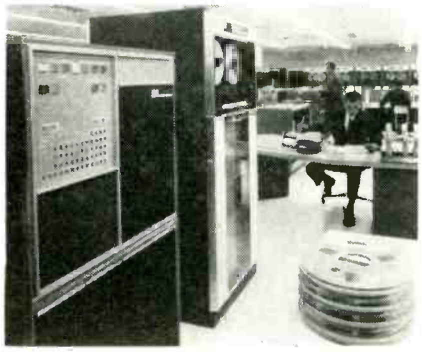
A Ballistic Camera Synchronization System designed cooperatively with the Ballistic Research Laboratories and developed and manufactured by the Electronic Engineering Co. of California, Santa Ana, Calif., has been formally accepted by BRL, Aberdeen Proving Ground, Md. Tests on the system were conducted cooperatively with NASA and Army Ballistic Missile Agency at the Cape Canaveral Firing Range. The system is capable of synchronizing Ballistic Cameras with rotating shutters to within 0.1 msec. Cameras for tracking space vehicles or capsules may be located as much as 200 miles apart and still retain this accuracy.

Communication System Links Computers

A 68-mile long telephone cable and microwave network now links the IBM data processing facilities in NYC and Poughkeepsie, N. Y.

Specially-developed IBM 1945 magnetic tape transmission units send information between the two points in either direction or both ways simultaneously, at a rate of 15,000 characters per second.

The new 1945 unit can send and receive as fast as IBM computers read and write magnetic tape, a rate ranging up to 62,500 characters/second. Such speed will allow a large company or organization to distribute various jobs among its multiple computer facilities without regard to physical distance.



Communication system utilizes an IBM 1945 magnetic tape transmission unit (left) at each location, telephone cable and a Bell System microwave network.

Programmers at either end of the link can test and revise their programs on computers at the other location by transmitting the appropriate data there and receiving back processed results for evaluation. Output is in the form of punched cards, magnetic tape or printed copy.

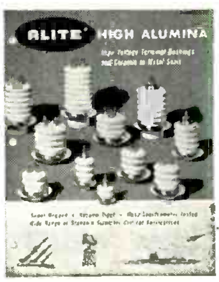
ONE INTEGRATED SOURCE for Ceramic-to-Metal Seals

In all phases of planning for high-alumina ceramic-to-metal seals you can rely on Alite for the "know-how" and "do-how" required to produce highest quality for critical applications.

From design to finished part, every manufacturing step — including formulating, firing, metalizing and testing — is handled within our own plant and carefully supervised to assure strict adherence to specifications, utmost uniformity and reliability.

To simplify design problems and speed delivery, Alite terminals, feed-throughs and cable end seals are available in over 100 standard sizes.

INSIDE LOOK AT ALITE—



Write today for Bulletin A-40R—Full technical data on standard and special Alite ceramic-to-metal seals.

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88-H

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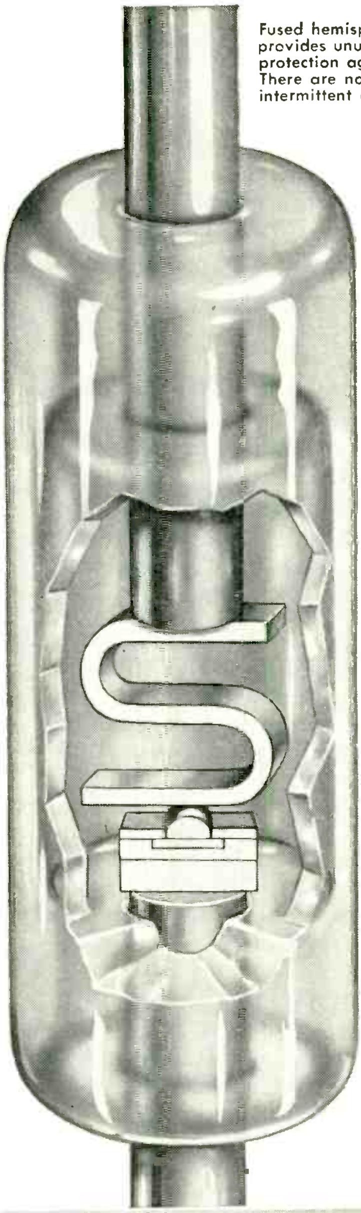


General Electric's new *PEP* silicon diodes bring you a unique design combination that can add important assurances of performance and reliability in your high speed switching circuits.

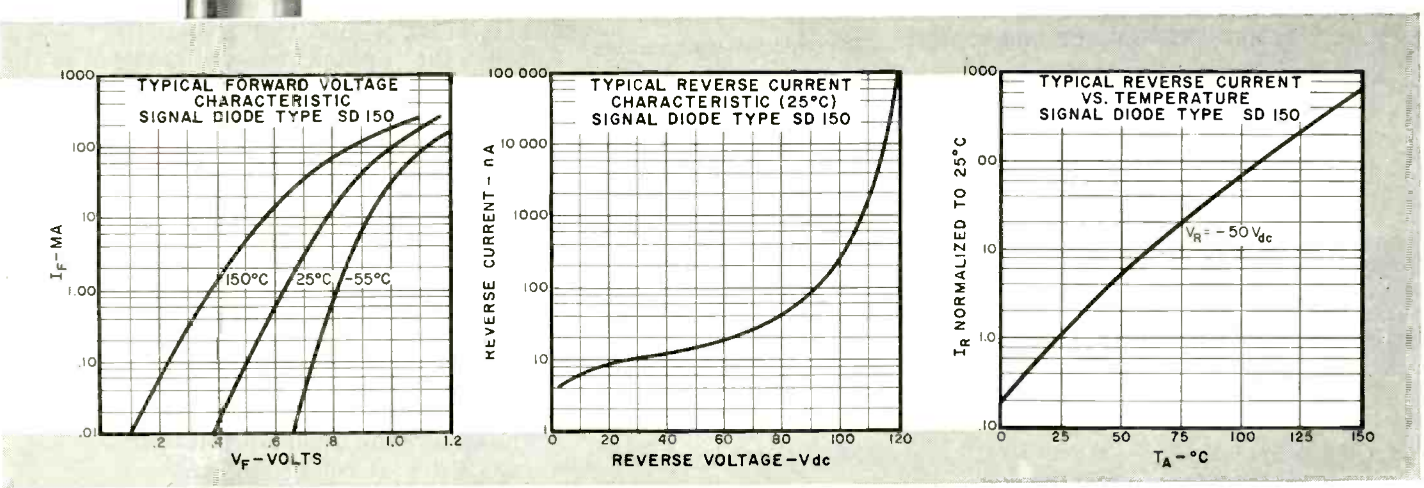
Gaseous *planar* diffused junction means high breakdown voltage with low capacitance.

Thin *epitaxial* layer on low resistivity substrate gives negligible body drop and increased uniformity from diode to diode.

Surface *passivation* is applied before the junction is formed for maximum protection against contamination.

In addition to ultra-fast switching speed, your designs benefit from a 5-to-1 improvement in conductance over presently available units. All General Electric diodes are aged at 200°C for a minimum of 60 hours. A life test of 1000 hours (50 volt reverse bias at 150°C) is made on a sample from each lot before lot shipment is allowed. This is a more severe test than the usual high temperature storage test without applied voltage. Other restrictive tests performed on a sample from each lot are: oven storage, temperature cycling, room temperature storage, moisture resistance, solderability and lead fatigue. Criteria for lot acceptability are: stability of forward voltage, breakdown voltage and reverse current.

Put *PEP* in your designs with General Electric High Speed Diodes. For complete technical information call your Semiconductor Products District Sales Manager, or write Semiconductor Products Department, Section 13K109, General Electric Company, Electronics Park, Syracuse, New York. In Canada: Canadian General Electric, 189 Dufferin Street, Toronto, Ont. Export: International General Electric, 150 E. 42nd St., New York 17, N. Y.



GENERAL ELECTRIC

Tele-Tips

THE RELIABILITY STANDARD for space, according to Aerojet General Corp.'s scientists will be fifty years. Orbiting satellite equipment will be expected to function continuously for that period without defect.

A JERK, by any other name—is still "a vector that specifies the time rate of change of the acceleration; jerk is the third derivative of the displacement with respect to time." (According to the American Standard Acoustical Terminology—S1.1-1960.)

FIRST ISOTOPE - POWERED automatic weather station will soon go into operation in the Canadian Arctic, fulfilling a long time dream of weather men around the world. Power to operate the station will be provided by an isotope of strontium-90. Station and power source are housed in a cylindrical insulated container approximately 8 ft. long.

UNIQUE TRAFFIC CONTROL system developed by General Motors Research Laboratories has a series of lighted speed signs that tell the motorist to speed up or slow down in order to arrive at the next traffic signal while it is green. The motorist entering the system at either end need only obey the lighted speed signals which vary from 25 to 45 miles per hour.

MORE SOLAR ENERGY research has been urged on the Government by Senator Hubert H. Humphrey (D., Minn.). Humphrey emphasizes "the tremendous potential of solar power devices to our Nation's program overseas." One of the items that Humphrey has in mind is a solar power device known as "the Community Listening Center" developed by Hoffman Electronics. This solar powered device is a small radio and amplifier which could be dropped into remote areas. The International Cooperation Administration has purchased four of the units for experimental uses in villages in Paraguay, India, Afghanistan, and Pakistan.

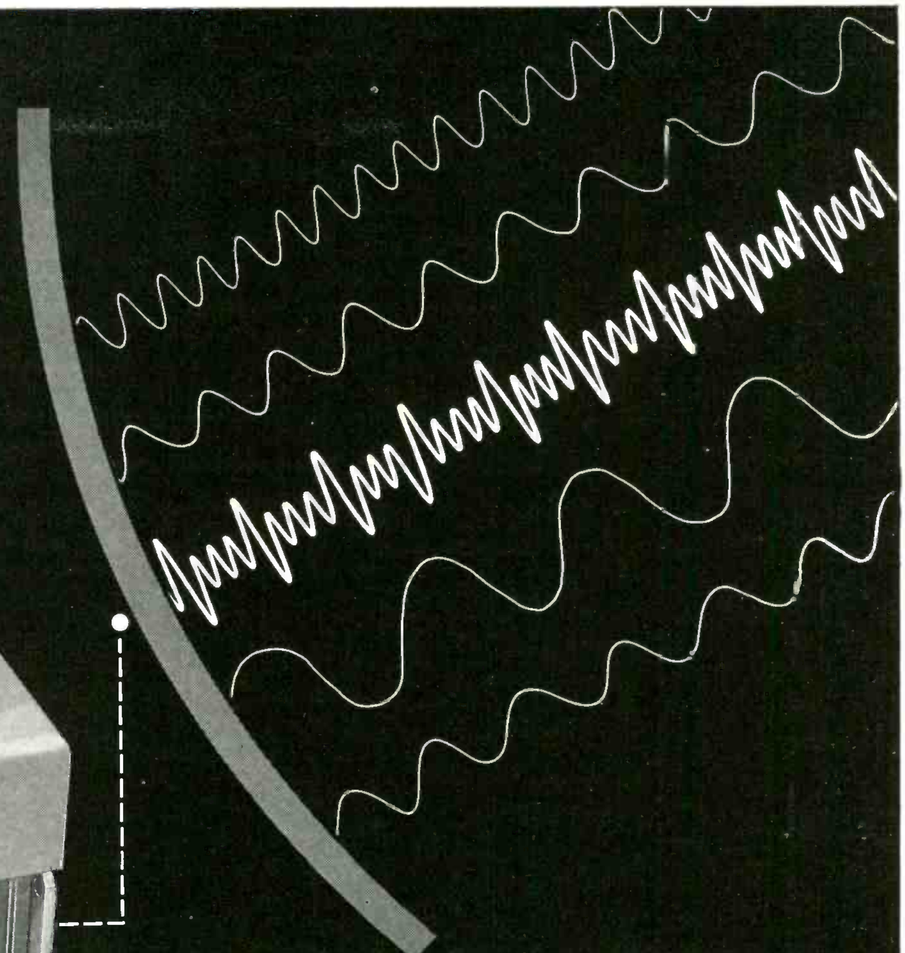
Tele-Tips

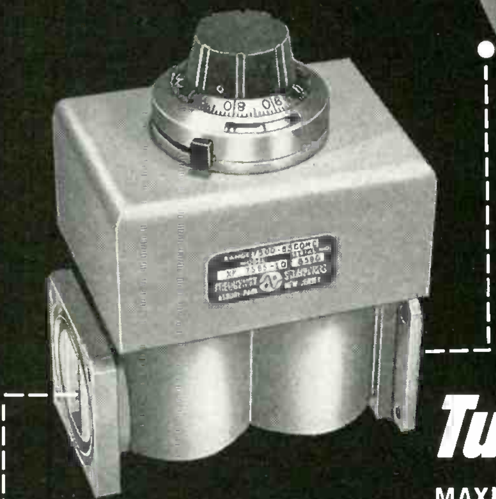
"TRUE-MOTION" RADAR that duplicates the navigation scene as it appears from the ship's pilot house and eliminates most of the prodding required of conventional radar is now being turned out by RCA. The new type radar provides the ship's navigator with a forward view picture of his own vessel moving "up" on the radar screen. The nuclear powered "N. S. Sylvana" will get the first set.

CAMPUS RECRUITERS often reject the student with the liberal arts background, avoid the nonconformist, mislead the student about work requirements and don't know the future manpower needs of their own companies, charges George S. Odiorne of the University of Michigan. "Particularly lamentable," he says, "is that while lip service is paid by senior company officers to the idea of hiring liberally educated men, it is the professionally trained person who gets the most attractive job offers. And this has a tangible effect on the student's emphasis on the more academic subjects, especially in the classics, literature, and the arts courses."

THE PATENT OFFICE last month granted its 3,000,000-th patent; this one issued to Dr. Kenneth R. Eldridge, a staff scientist of Stanford Research Institute. The patent is assigned to GE's Computer Dept., Phoenix, Ariz. The invention covered a magnetic reading device, developed for the Bank of America's electronic data system for processing bank checks at a speed of 750 per minute.

FALLOUT from the Russian atmospheric tests is being closely watched here. The Weather Bureau is keeping a close eye on the high altitude winds that are spreading the radio active debris from the Russian tests around the world. Wind is only one of the factors; the others are the season of the year when the blast occurs, the altitude to which radioactive debris is carried, and the latitude of the earth at which the test is conducted.





Tunable-X Band Filters

MAXIMUM REJECTION • LOW INSERTION LOSS • DELIVERY FROM STOCK

Now, Frequency Engineering Laboratories, world leader in microwave filter technology, introduces a new series of precision tunable bandpass filters covering the range of 7 to 12.5 Gc — assembled and delivered from stock in two weeks or less!

These filters feature a bandwidth of 8 to 12 mc at 3 db and 60 mc at 30 db with 2 db insertion loss... VSWR of 1.5 max. at F_0... temperature stability of 3 cps/Mcs/°C maximum drift over wide temperature range... two direct-coupled TE_{111} mode cylindrical cavities with single tuning control... counterdial and calibration chart or slotted shaft adjustment. Price: $398.00 each (less quantity discount).

Frequency Engineering Laboratories' 14 years of experience in the development and production of high performance microwave filters is available to you without obligation. Look into our capabilities for special preselectors with balanced mixer as well as low bandpass and band rejection filters for both high and low power applications. Write for Bulletin P-26102 or send specific bandwidth and other requirements to Department KF.

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LABORATORIES ...... formerly FREQUENCY STANDARDS
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Center for new ideas in microwave technology — Discriminators, Antenna Couplers, Diplexers, Wavemeters, Reference Cavities, Signal Sources, Directional Couplers, Antennas, Cavities

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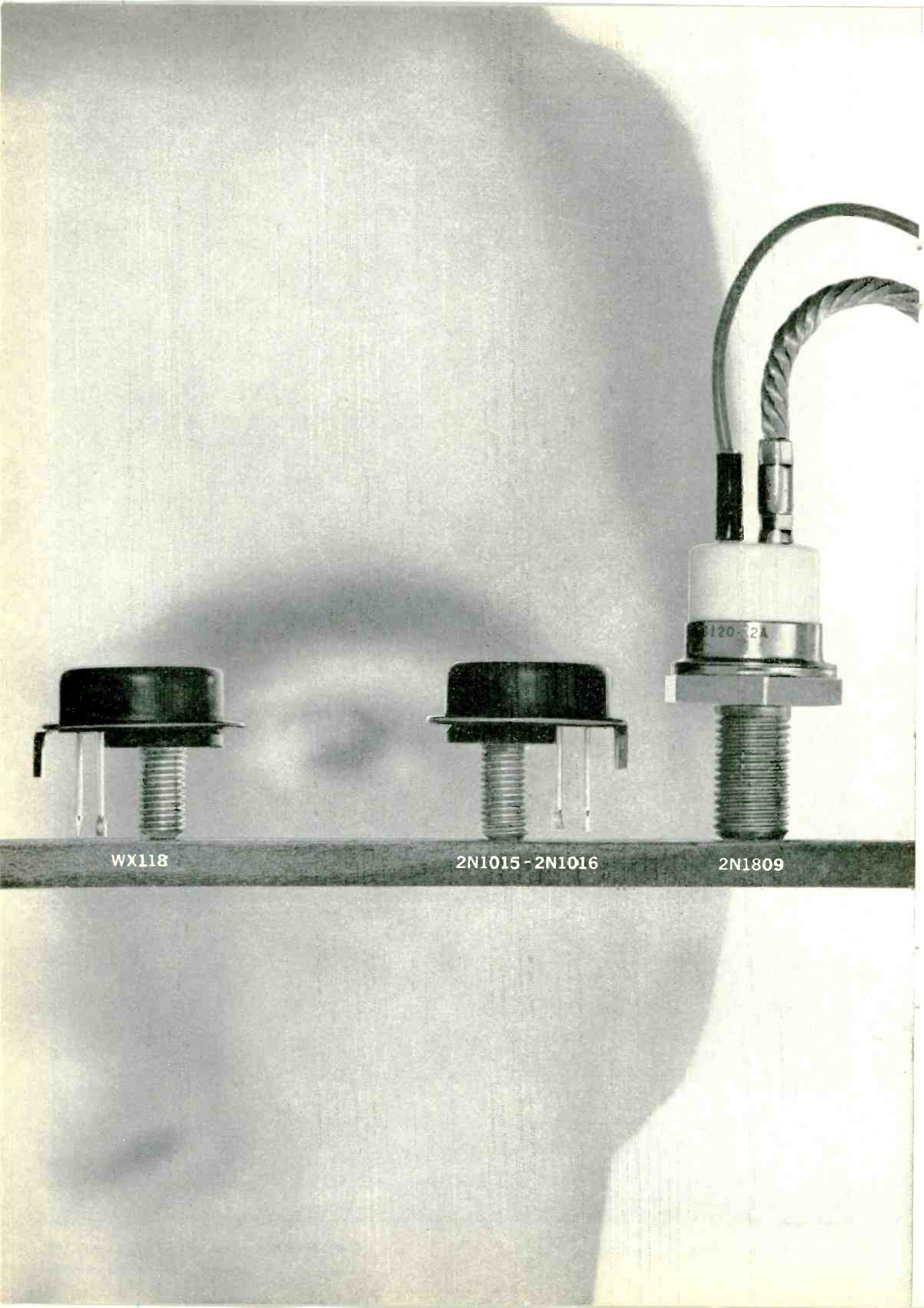
WX118
2N1015 - 2N1016
2N1809

Look to Westinghouse for Silicon Power Transistors with lowest saturation resistance

LSR* =.037 Lowest saturation resistance ratings in the industry enable design engineers to obtain threefold increases in power-handling capability. Now—with these higher performance specifications you can replace germanium units and gain the silicon power transistor advantages of reduced heat sink size . . . higher allowable ambient . . . improved control range . . . and upgraded reliability in almost all circuits.

	I_C	V_{CE}	Typical R_{CE} (SAT)
2N1809-2N2109 series	30 A	50-200V	.037
2N1015-2N1016 series	7.5 A	30-200V	.25
WX118 series	10 A	50-150V	.22

*Lowest Saturation Resistance

2N1809-2N2109 series. New 30-amp "Rock-Top" transistors . . . world's most powerful! With 30-amp, 200-volt, 250-watt ratings these newest Westinghouse series 2N1809 and 2N2109 transistors are designed to meet the most exacting high power applications. Germanium-level saturation resistance (.037 ohms), and freedom from secondary breakdown mean highest efficiency and operating reliability.

WX118 series. World's highest gain power transistors provide current gain of 400 at 10 amps! New Westinghouse Type WX118 high-gain silicon transistors simplify circuitry, increase reliability, reduce cost of assembly. They're ideal for application in high power, high efficiency regulators, inverters and switching circuits. Saturation resistance is only 0.22 ohms.

2N1015-2N1016 series. Highest reliability from production-proved 150 watt designs. Get maximum circuit reliability at no extra cost by specifying the Westinghouse 2N1015-2N1016 series. These popular transistors have been field-proven in thousands of operating equipments. They can replace lower rated transistors (2N1489-2N1490, 2N1069-2N1070, 2N389 and others), and give you up to twice-the-power derating margin. In addition to the exclusive rating characteristics of these transistors, you get greater assurance of performance reliability from:

- **True voltage ratings.** Westinghouse transistors can be operated continuously at their full published ratings into highly inductive loads. True Voltage Ratings are verified by 100% Power Testing.
- **100% Power Testing.** Each Westinghouse transistor is 100% Power Tested before leaving the plant. Tests are conducted over the full operating range—under all conditions of base bias and collector current at maximum rated dissipation.

For more information or technical assistance, see your nearest Westinghouse representative or write: Westinghouse Electric Corporation, Semiconductor Department, Youngwood, Penna. *You can be sure . . . if it's Westinghouse.* SC-1054

2N2109

For immediate "off-the-shelf" delivery, order from these Westinghouse Distributors:

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Palo Alto, Cal./DA 1-7541
NEWARK ELECTRONICS CO. Inglewood, Cal./OR 4-8440

Westinghouse

ELECTRON TUBE NEWS from SYLVANIA

Recording data on film with fiber optic CRT.

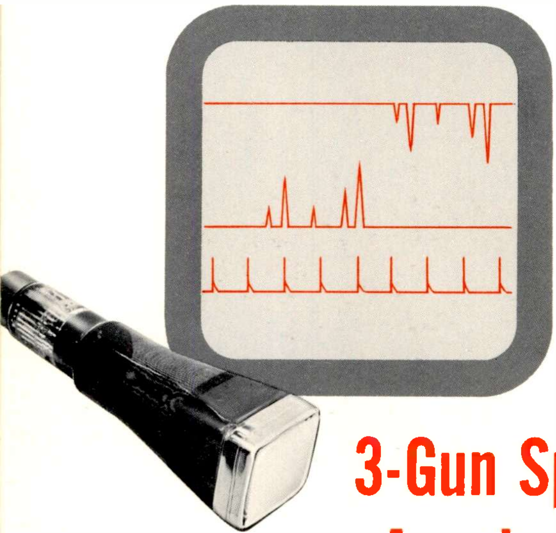
At Sylvania, the amazing phenomenon of optical fibers is revolutionizing resolution capabilities of cathode ray tubes. These tiny light pipes, transparent dielectric cylinders only 10 microns in diameter, conduct light from the phosphor screen to the outside surface of the CRT face. This dramatic new technique completely eliminates parallax. Used in photo-recording applications, it eliminates lens requirements, enables direct photoprinting.

Now available for sampling are: 5″ diameter CRT's with faceplates composed entirely of optical fibers or with a .250″ x 4.125″ array of optical fibers for linear scanning; a rectangular 3″ x 1½″ CRT featuring a .250″ x 2.750″ array of fiber optics. These remarkable tubes can be supplied with either electrostatic or magnetic deflection and focus and with aluminized or nonaluminized P11 or P16 screens.

Currently under development are fiber optic CRT's capable of magnifying images and of coding signals by "scrambling" light transmission.

If your project calls for exceptionally high resolution in photo recording, flying spot scanning, mapping or reconnaissance systems, these extraordinary developments deserve your careful examination. Ask your Sylvania Sales Engineer for complete information.

NEW from SYLVANIA!



3-Gun Spiral Accelerator

for multiple tracking radar

Sylvania SC-3090 is a high-precision instrument with a 5½″ square face. Its tri-gun structure is so accurately designed and aligned it provides a tracking error of less than .055″ at any point on the tube face. Electrostatically deflected and focused, it offers high deflection sensitivity, high resolution and writing speed, minimal pattern distortion. SC-3090 is available with aluminized screen and P19 phosphor.

Single-gun Spiral Accelerators, 5BGP/T51, 5BHP/T54, are available with a new brighter phosphor and "Bonded Shield" safety cap for increased image readability. Assembled on Sylvania-developed mounting jigs to exceptionally close tolerances, they provide superlative precision performance.

Absolute Max. Ratings	SC-3090	5BGP—	5BHP—	Units
Anode #3 Voltage	10,500	13,200	13,200	Vdc
Isolation Shield Voltage	3,500	2,300	2,300	Vdc
Deflection Plate Shield Voltage			2,300	Vdc
Anode #2 Voltage	3,500	2,200	2,200	Vdc
Anode #1 Voltage	1,750	880	880	Vdc

Low drain heater-cathode design for battery-powered applications . . .

Now in 3 CRT families!

Typical of continuing Sylvania advancements in the "state of the art" is the remarkably efficient heater-cathode assembly employed in Sylvania-3BGP—, 3BMP—, SC-3016. With a rating of 1.5V @ 140mA, it consumes only 0.2 watts and enables battery life of 400 hours from a #6 dry cell operating up to 2 hours daily. Further, it possesses extremely low mass (0.05″ dia., 0.011″ thick), thereby enhancing resistance to shock and vibration, so vital for reliable, portable operation. Significantly, this unusual development is adaptable to virtually any existing CRT design.

Key Characteristics	3BGP—	3BMP—	SC-3016	Units
Anode #3 Voltage		6600*		Vdc
Anode #2 Voltage	2750*	2200*	2750*	Vdc
Anode #1 Voltage	1100*	1500*	1100*	Vdc
Face Dimension	1½x3	3	1⅛	Inches
Over-All Length	9¼	10	6	Inches

*Absolute maximum ratings

Low grid drive! Low current heater!

Sylvania-10ANP for radar display

Sylvania-10ANP is ideally suited to compact radar equipment. Here's why: small yoke for increased sensitivity, low grid voltage requirements and 300mA heater enable excellent performance from transistorized power supplies; further, it features small, 0.840″ diameter neck, short over-all length of only 16″ and 9-pin miniature base.

Sylvania-10ANP offers magnetic deflection and focus, aluminized screen and a wide range of phosphors. Currently under development at Sylvania are 5″, 7″ and 12″ versions of the 10ANP.

If your design demands specialized cathode ray tubes, call on the high quality-quantity capabilities of Sylvania. For technical data on specific types, write Electronic Tubes Division, Sylvania Electric Products Inc., 1100 Main Street, Buffalo 9, New York.

NEEDED NOW:

Radiation-Resistant Components!

Few reliability studies hold such great import for national security as those investigating radiation effects on electronic components. Will, for example, electronic components withstand continuous radiation from the reactor of a nuclear-powered craft?

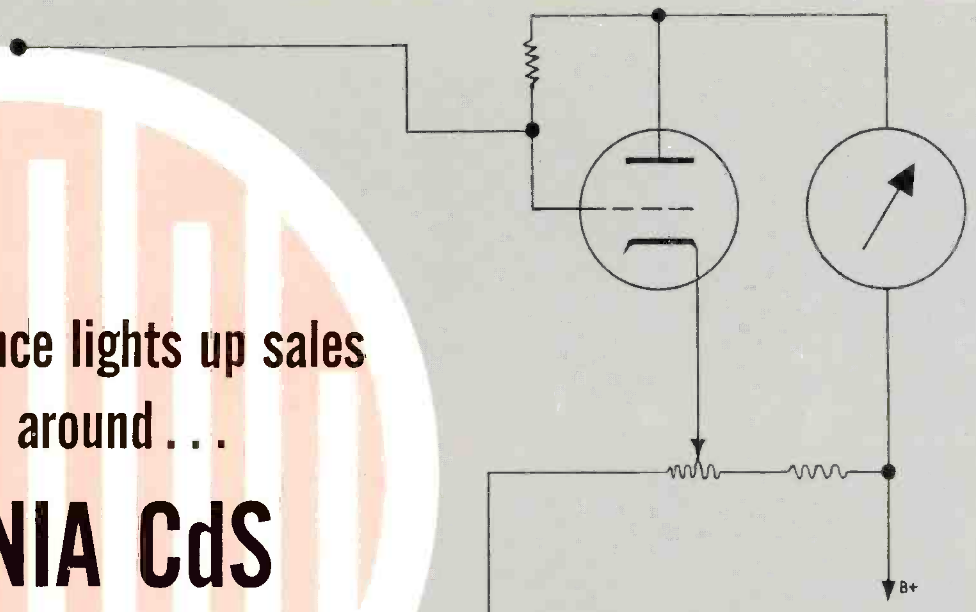
Intense radiation is known to have disastrous effects on solid-state performance. How, then, do you design for reliable, compact circuitry without imposing prohibitive weight penalties of massive shielding?

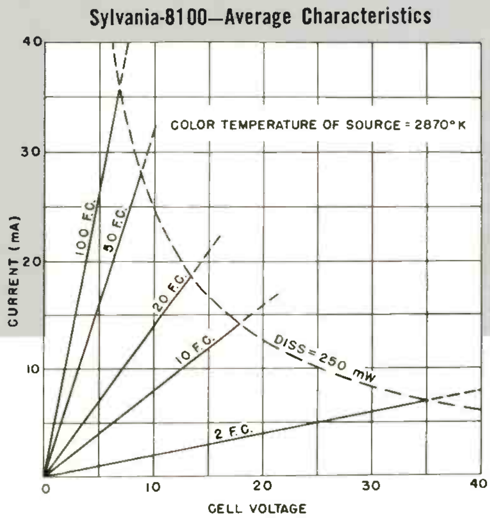
One good way: design around radiation-resistant Sylvania Gold Brand Subminiature Vacuum Tubes. All Gold Brand Subminiature types are rated for steady state radiation resistance. Extensive testing prove them capable of withstanding 10^{12} neutrons/sq. cm./sec. dose rate for a total dosage of 10^{16} neutrons/sq. cm. Further, Gold Brand Subminiature Tubes tolerate pulses of pure gamma radiation of approximately 10^{6} R./sec. Compare this with the gamma dose rate of 0.1 R./sec. absorbed ¾ mile from a 20KT bomb—it's well within the operating capability of Gold Brand Subminiature Tubes.

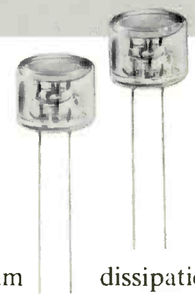
Vacuum tubes are compatible not only with nuclear environments but extreme shock and excessive temperatures. Extended periods of storage, too, have little or no effect on vacuum tubes. Ask your Sylvania Sales Engineer for complete information on the many remarkable capabilities of electronic tubes. He can supply you with detailed documentation of Sylvania Gold Brand Subminiature Tube reliability.

bright performance lights up sales when you design around . . .

SYLVANIA CdS Photoconductors







Sylvania-8100 is the first of a new family of Cadmium Sulfide photoconductive devices for industrial-commercial light-actuated control applications. Proven in self-adjusting TV brightness and contrast controls, Sylvania-8100 features two foot-candle resistance of 5000 Ohms and a minimum dark resistance of 200,000 Ohms.

Sealed-in-glass techniques provide a moisture-resistant device, protect wafer, assure long, reliable life.

Blue Dot Protection on light-sensitive wafer indicates device is vacuum-tight. If the unusual occurs and a leak develops, blue dot turns to pink . . . a special confidence feature on all Sylvania photoconductors.

Hydrogen-Filled after thorough evacuation; improves dissipation characteristics, enhances stability and uniformity.

Automated Techniques provide excellent control of physical characteristics such as the configuration of electrodes on the CdS wafer, assure superior characteristics of uniformity.

If your design area includes lighting, sorting, door controls, headlight dimmers, data processing, fire or smoke detection or similar work, contact your Sylvania Sales Engineer. He will give you complete information on this and other photoconductors under development at Sylvania. For technical data on Sylvania-8100, write Electronic Tubes Division, Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y.

SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

P-1289-3

Letters to the Editor

Engineers Salaries

Editor, ELECTRONIC INDUSTRIES:

I was surprised to read on Page 4 of the August issue of ELECTRONIC INDUSTRIES that graduates in Electrical Engineering with an interest in electronics are receiving offers at the average of $490 per month with a high of $528 per month. Actually, the news item relating to this matter is somewhat garbled and it was obvious from the news item itself that these items cannot be taken at face value. Our engineering graduates this year are averaging $540 per month and this is in line with reports from other major schools of engineering.

George R. Town
Dean

GRT/fc
Iowa State University
of Science and Technology
Ames, Iowa

Dear Mr. Town:

A combination of a typing error and the fact that the error was not detected before going into print accounts for the mistake.

Ed: Starting with the second sentence, the item should have read:

"Fifty CSPE graduates accepted offers from industry with an average of 610/mo., with a high of 900/mo. and a low of 525/mo. Seven graduates accepted offers from Federal Government installations at an average of 490/mo., with a high of 528/mo., (GS-7) and a low of 444/mo. (GS-5)."
SR/alm

What Price RELIABILITY?

Editor, ELECTRONIC INDUSTRIES:

I am currently working on a high reliability system for air borne equipment. Your article *What Price Reliability*, (September 1961) fully summarizes the major problems and difficulties in this field.

I feel this article is of great interest to this department. Please send me six (6) copies so that I can distribute them to the other members of my group.

Sherman Cheu
Engineer

Philco Corporation
Government and Industrial Division
Western Development Laboratories
3875 Fabian Way
Palo Alto, Calif.

Editor, ELECTRONIC INDUSTRIES:

Having read and enjoyed your timely article, *What Price Reli-*

(*Continued on page* 56)

Letters to the Editor

(*Continued from page* 55)

ability? in the September 1961 issue of ELECTRONIC INDUSTRIES, I would appreciate twelve (12) reprints for distribution within Ryan Electronics.

Advance thanks for your cooperation.

D. M. Paff
Reliability Engineering
Ryan Electronics
Div. Ryan Aeronautical Co.
San Diego 12, Calif.

Editor, ELECTRONIC INDUSTRIES:

I would like to request reprints of two fine articles in your September 1961 issue. The articles are: *Check-list for Marketing a New Product* and *What Price Reliability.*

George A. Needham
Mgr. of Administration
Integrated Circuits
Motorola, Inc.
5005 East McDowell
Phoenix, Arizona

Editor, ELECTRONIC INDUSTRIES:

Would you please forward five reprints of the article entitled *What Price Reliability?* which appeared in the September 1961 issue of ELECTRONIC INDUSTRIES.

H. J. Rounds, Jr.
Executive Vice President
Benson-Lehner Corp.
1860 Franklin St.
Santa Monica, Calif.

Editor, ELECTRONIC INDUSTRIES:

Our Reliability Engineering group would appreciate receiving, if possible, six reprints of the article *What Price Reliability* by John E. Hickey, Jr. The article appeared in the September 1961 edition of ELECTRONIC INDUSTRIES.

D. G. De Jong
Reliability Engineering
The Hallicrafters Co.
5th and Kostner Avenues
Chicago 24, Illinois

Editor, ELECTRONIC INDUSTRIES:

Please send to the writer a reprint of the article, *What Price Reliability?* which appeared in the September issue of ELECTRONIC INDUSTRIES.

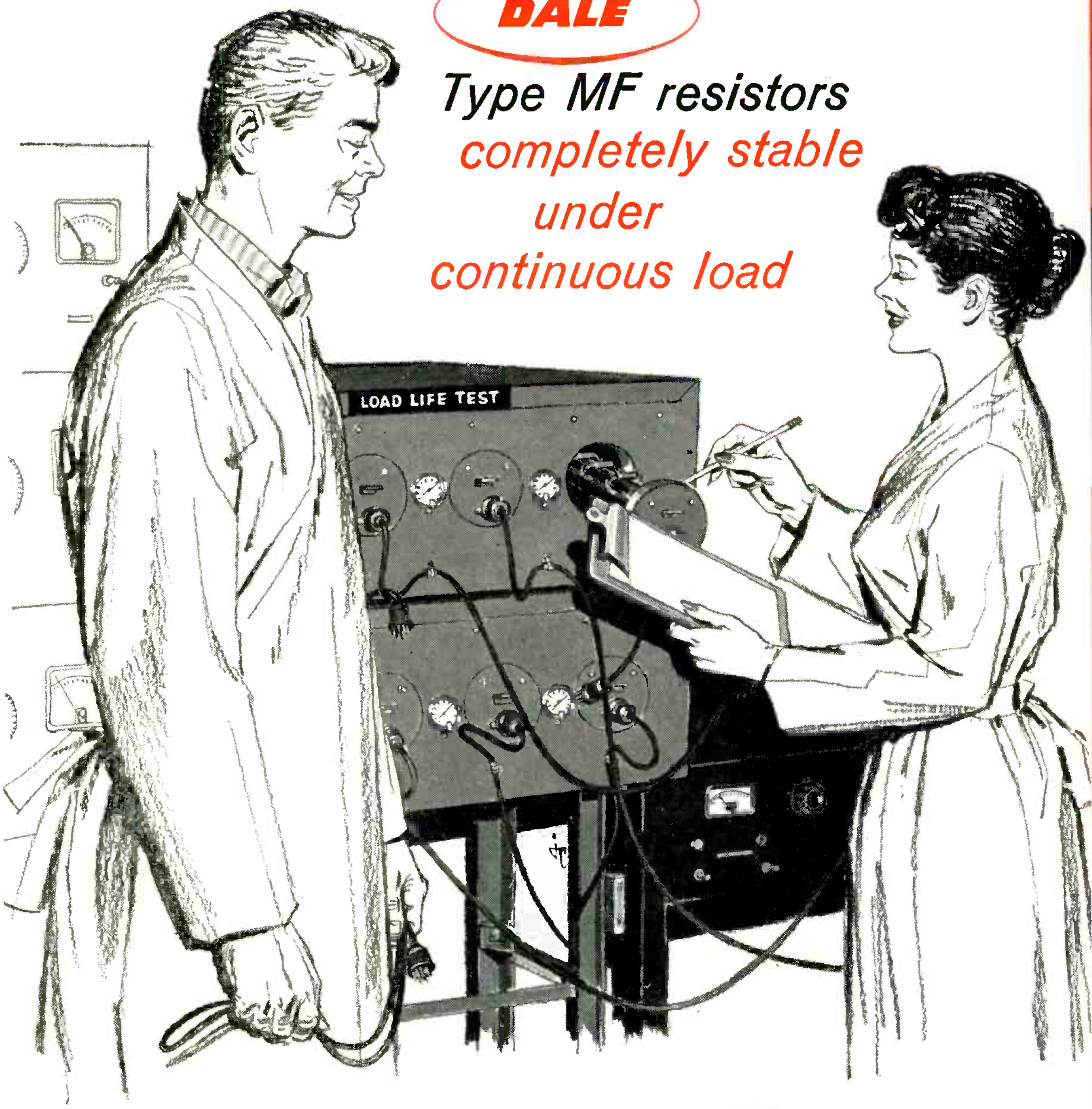
Quote, please, the cost of reprints of this article in quantities 2-100 copies.

T. E. Tucker, Design Engineer
Tantalytic Foil Capacitor
Engineering
General Electric Co.
Capacitor Department
Irmo, South Carolina

(*Continued on page* 60)

DALE

Type MF resistors completely stable under continuous load



Under any circumstance...placed under continuous load, or held "in reserve" for months...operating under severe environmental conditions of shock, vibration, or humidity . . . Dale precision resistors retain their stability.

Stability is inherent in Dale resistors because it has been firmly infixed by design and methods of manufacture . . . methods which have reached new levels of achievement as the result of Dale's super-high reliability development program.

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

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

Hathaway INSTRUMENTS INC.

DALE ELECTRONICS, INC.

1304 28th Ave., Columbus, Nebr., U.S.A.

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

DALE TYPE MF RESISTORS

METAL FILM • MOLDED • PRECISION

These new resistors combine the advantages of Dale molding techniques with advanced high vacuum evaporated metal film procedures to provide the best characteristics of wire wound resistors, while retaining miniature size. Inherently good R.F. characteristics and low noise levels.

- RATED AT 1/8 watt, 1/4 watt, 1/2 watt, 1 watt, 2 watts
- RESISTANCE RANGE from 100 ohms to 4 megohms, depending on type
- TOLERANCE ± 1%
- TEMPERATURE COEFFICIENT ± 50 and ± 100 P.P.M.
- FULL POWER to 125° C.
- COMPLETELY INSULATED; complete protection against moisture and salt spray

Write for Bulletin R 43 and handy cross reference file card

A full line of capacities from 10 to 52 points. Capable of millions of steps without adjustment.

Fast "Off-The-Shelf" delivery

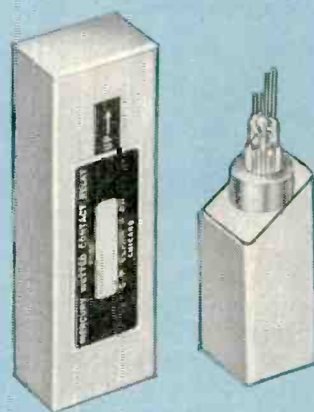
Overnight delivery on many items at factory prices

When standard CLARE relays or switches meet your needs, distributor service saves you time, costs you no more.

Top quality
—the same fine design and long life you get in CLARE custom-built relays and switches.

Easy purchasing
—you can order CLARE relays at the same time you purchase other components... have them delivered together.

Engineering assistance
—always available from CLARE field engineers who work in close cooperation with CLARE distributors.



NOW AVAILABLE
... mercury-wetted contact relay modules for mounting on your own printed circuit board

Type HGM relay module (left) with cut-away (right) showing mercury-wetted switch capsule and coil potted in steel enclosure.

Your nearby CLARE distributor can now supply you with the new CLARE mercury-wetted relays, steel enclosed and ready for mounting. They combine the famous CLARE billion-operation reliability with unusual ease of handling and application. You can choose either the standard CLARE HG relay module or the HGS, super-fast and super-sensitive. Each module contains the CLARE mercury-wetted contact switch capsule with contacts continually wetted by capillary action. They never bounce, never get dirty, never weld and never wear out.

A compact telephone type relay of unequaled long life and superior performance.

A highly reliable switching device for single or multiple circuit control . . . wide mounting versatility.

Single or multiple switch capsules potted in steel container. Gives billions of operations with no maintenance.

A crystal can relay with unusual flexibility and a variety of mounting styles.

# of top-quality Clare relays

Circle 39 on Inquiry Card

From these distributors

PACIFIC COAST

1. **Puget Electro Products**
   5319 Fourth Ave., South
   Seattle 8, Washington
   Tel: Parkway 5-9700

2. **Bell Electronic Corporation**
   1070 O'Brien Drive
   Menlo Park, California
   Tel: Davenport 3-9431

2. **Bell Electronic Corporation**
   306 E. Alondra
   Gardena, California
   Tel: Faculty 1-5802

2. **Bell Electronic Corporation**
   8072 Engineers Road
   San Diego 12, California
   Tel: Browning 8-4350

SOUTHWEST

3. **Radio Specialties Co., Inc.**
   6323 Acoma Road, S.E.
   Albuquerque, New Mexico
   Tel. Amherst 8-3901

3. **Radio Specialties Co., Inc.**
   209 Penn Avenue
   Alamogordo, New Mexico
   Tel: Hemlock 7-0370

4. **Engineering Supply Co.**
   6000 Denton Drive
   Dallas 35, Texas
   Tel: Fleetwood 7-6121

5. **Harrison Equipment Co., Inc.**
   1422 San Jacinto St.
   P. O. Box 1505
   Houston 1, Texas
   Tel: Capitol 4-9131

6. **Engineering Supply Co.**
   1124 East Fourth Street
   Tulsa 20, Oklahoma
   Tel: Luther 3-8121

CENTRAL

10. **Relay Sales, Inc.**
    P. O. Box 186
    West Chicago, Illinois
    Tel: 231-1100

11. **Srepco, Inc.**
    314 Leo Street
    Dayton 4, Ohio
    Tel: Baldwin 6-2546

12. **Pioneer Electronics Supply Co.**
    5403 Prospect Avenue
    Cleveland 3, Ohio
    Tel: 432-0010

13. **M G Electronics & Equip. Co.**
    201-3 South 18th Street
    Birmingham 3, Alabama
    Tel: FA 2-0449

EAST

7. **R & D Supply, Inc.**
   1492 Highland Ave.
   Needham 92, Mass.
   Tel: Hillcrest 4-4500

8. **Avnet Electronics Corp.**
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   Westbury, L.I., New York
   Tel: Edgewood 3-5800

9. **Electronic Wholesalers, Inc.**
   1301 Hibiscus Boulevard
   P. O. Drawer 1655
   Melbourne, Florida
   Tel: PA 3-1441

9. **Electronic Wholesalers, Inc.**
   9390 N.W. 27th Ave.
   Miami 47, Florida
   Tel: Oxford 6-1620

C. P. Clare & Co., 3101 Pratt Blvd.,
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In Europe: Europelec,
les Clayes-sous-Bois (S.et O.), France.

C. P. CLARE & CO.

Relays and related control components

Letters to the Editor

(*Continued from page* 56)

New Product Treatment

Editor, ELECTRONIC INDUSTRIES:

In the September issue of ELECTRONIC INDUSTRIES you included a product release on our new coaxial pill varactors.

For the benefit of design engineers I used a photograph of models to show the configuration most accurately. The actual diodes were pictured next to a postage stamp for size.

Someone on your staff took the time to identify the models as such on the photograph (see page 181) before you made your cut. It was a simple gesture but like the high editorial caliber of your magazine, the high caliber of your editing staff does not go unnoticed.

Robert J. Allen
Advertising and Public Relations Manager

Microwave Associates
Burlington, Massachusetts

Many Thanks—

Editor, ELECTRONIC INDUSTRIES:

Electronic Industries for April 1961 is a fine issue. In fact EI quality and utility has been climbing for a solid year.

W. L. Anderson
Research Specialist
United States Air Force

Box 530
Devine, Texas

New Skill—Writing!

Editor, ELECTRONIC INDUSTRIES:

I enjoyed reading the editorial *Writing—Newest Engineering Skill*, by Harry Baum, in the March 1961 edition of ELECTRONIC INDUSTRIES, page 278 and 279.

As Mr. Baum states, there are some people who can write letters or papers that one can enjoy reading, while others write in such a manner that it is a tough struggle following their train of thought.

Day by day, I find I am called upon to write letters and reports that should be well written and easy to read.

The writer would certainly appreciate a reprint of this article for his own personal file and future benefit.

Frank H. Johnson
Field Engineer

The Unitec Corporation
P. O. Box 5754
4003 Seven Mile Lane
Baltimore 8, Maryland

(*Continued on page* 64)

Semiconductor Specifiers

WHEN IS 2.0% BETTER THAN 0.001%?

When the chips are down, reliability is a crucial concern in the selection of a semiconductor source. Yet when you explore this parameter, you'll find a variety of vendor claims about the reliability of their devices. The statements run a wide gamut of values — and all the claims may be legitimate. One can easily find himself faced by the paradox: 2.0% can be better than 0.001% (for failure rates in %/1000 hours).

How come? Just how reliable are reliability figures anyway? Let's shake ourselves free of the emotion of claim and counter-claim and look at the logic of methodologies. The paradox exists because of basic differences in the different approaches used to reach a final value. In order to reach that final reliability figure, several assumptions must be made. One can be conservative or liberal in the assumptions he chooses to use. Thus, the 2.0% figure may be based on conservative assumptions, the 0.001% on liberal assumptions.

Now that you've come this far, let's dig in deeper. Obviously, a raw reliability figure is not enough — and should not be accepted on face value alone. We should ask what assumptions were made in reaching that figure. What assumptions should one look for? The following are the basic ones:

1. DEFINITION OF FAILURE: Just how is failure defined? Is it so strict as to call any deviation from initial values, however slight, a failure? Is it so liberal as to call any device which still passes current an acceptable one? You can see that the definition of failure becomes a screening system. How coarse or fine one makes that definition is a variable which affects the final reliability figure.

2. FAILURE RATE OVER THE COURSE OF TIME: Here is where one gets hung on the horns of dilemma. What normally happens is that data is taken for a base period of time (usually 1000 hours) and extrapolated. A good family of devices doesn't provide enough failure data in any reasonable length of time for a valid fit to any of the mathematical models of failure rate distributions. What happens then is that the reliability people make one of two assumptions. They may assume a constant failure rate . . . or they may assume a decreasing failure rate. The differences are much like academic arguments, one chooses his side according to his persuasion. The underlying dilemma is that the same set of data can give us two radically different failure rate values . . . depending on which assumption is used. It suffices to say that the constant failure rate assumption is the conservative one.

3. CONFIDENCE LEVEL: The statisticians will talk about the confidence level of the figures provided. Let's take the mystery out of the term. While the mathematicians will take exception to our forced simplification, after a moment's reflection they'll agree. A 90% confidence level, in the long run, means that 90% of the shipments will meet the specified standards and a 60% confidence level means that only 60% will get through. If that is what is wanted, an extra decimal place or two can be squeezed into that reliability figure by reducing the confidence level. The higher the confidence level, the more conservative the resulting reliability statements will be.

4. TESTING PROCEDURES: Just where are the test points? How many and which parameters are to be observed? To what stresses are the devices carried? What methodologies are used? We don't mean to imply that one approach is intrinsically superior to another. But we do mean to say that given exactly the same device, one can get different results according to the testing procedures used. Sometimes the differences can be quite gross. In comparing reliability data, one can't go wrong asking just how conservative or liberal the testing procedures are.

5. ARTIFICIAL ACCELERATION FACTORS: The rack life-testing used to determine reliability values is basically accelerated testing. In "normal" use, devices are not usually subjected to similar strains. Some vendors use the test data exactly as derived. In order to make the failure rate look better, others choose to apply an artificial acceleration factor. Their justification is that such a factor equates the data to normal usage. Obviously, using the the data as derived is the conservative procedure.

6. WHICH QUALITY CONTROL PROCEDURES: Most of the commonly used lot acceptance procedures for semiconductors follow Mil. Std. 105. But an alternate is permissible — MIL-S-19500B, Method B. This is the Lambda (λ) concept which specifically limits customer risk. The consumer specifies reliability assurance at a fixed confidence level and shifts the risk to the producer. In terms of the consumer's viewpoint, the Lambda (λ) approach is the conservative one.

If you're enchanted by the complexities of reliability, your own reliability experts would welcome the opportunity to explain the mysteries — and the problems of their profession.

We'll sum up by stating our position. The Raytheon Semiconductor Division has a set policy of always making the conservative assumption. We prefer to present you with the conservative figures which derive from the device itself rather than those based on a projected use of the device.

And when you see reliability ratings, make it a point to read between the lines, that's where real differences exist.

If you would like to know more about Raytheon Reliability, call or write the nearest Raytheon office for any or all of the following Quality & Reliability Bulletins:

Bulletin #221 — "Reliability — Fact or Fancy?" — an illuminating explanation of how to read and analyze reliability ratings.

Bulletin #222 — "Raytheon Reliability Assurance Program" — an informative discussion of how reliability assurance is generated and maintained.

Bulletin #223 — "Reliability of Raytheon PNP Germanium Alloy Junction Transistors" — facts and figures on the reliability of this popular family of devices.

Bulletin #224 — "A.Q.L. — What Is It?" — an enlightening report on the application of basic sampling inspection concepts to the task of specifying quality requirements.

Bulletin #225 — "Reliability of Raytheon High Current, High Frequency PNP Alloy Junction Germanium Transistors" — another comprehensive, fact-filled bulletin on a widely used family of devices.

RAYTHEON COMPANY

RAYTHEON

SEMICONDUCTOR DIVISION

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

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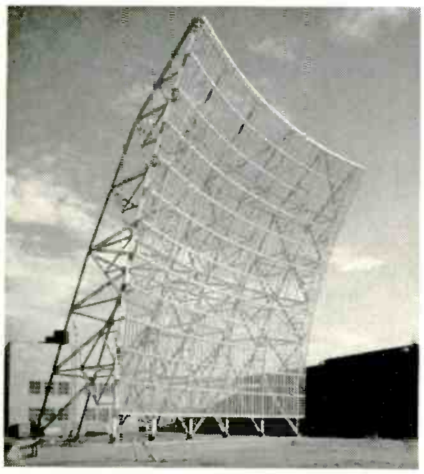
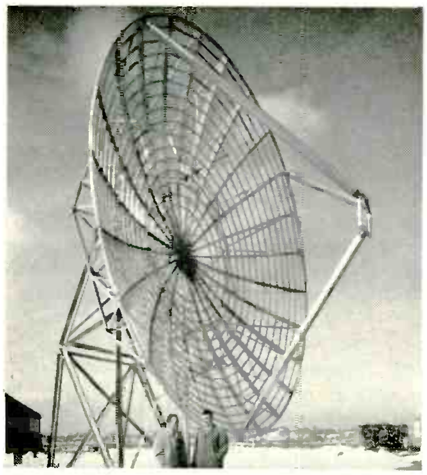
GOVERNMENT RELATIONS: Washington, D. C., MEtropolitan 8-5205

Circle 41 on Inquiry Card

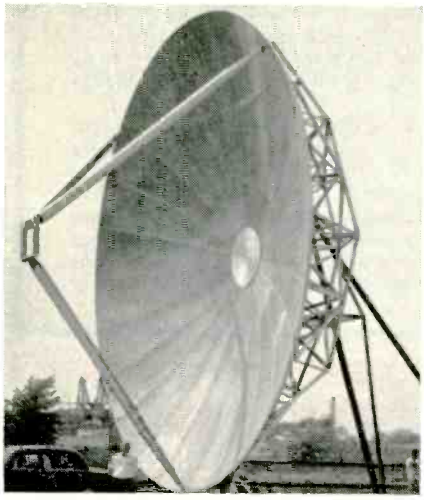
A complete line of antennas and antenna components



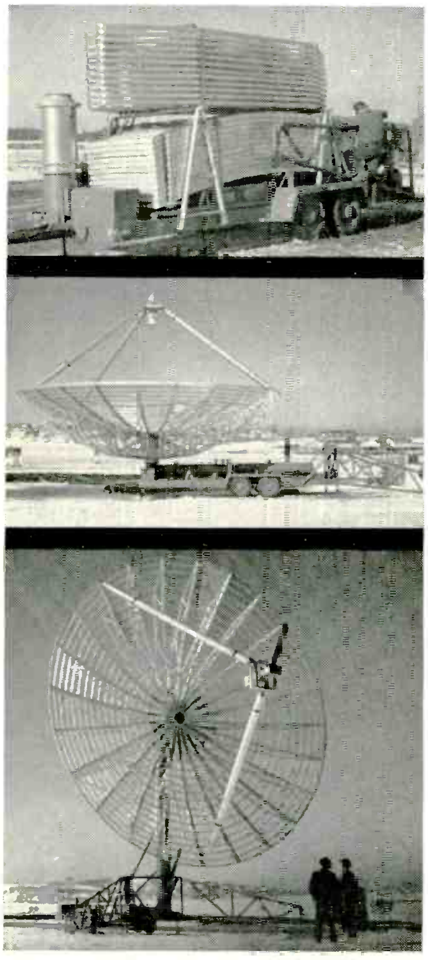
60-foot ground mounted tropospheric antenna. It's an offset paraboloid design, is fabricated of galvanized steel, and features maximum interchangeability and standardization of the various members.



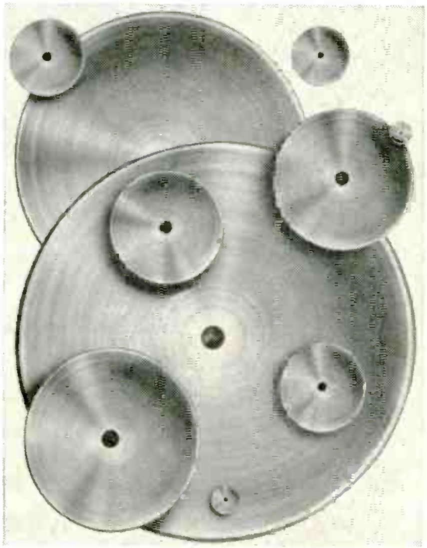
This is a 30-foot, mesh surface paraboloid (Model 101) which was designed for wide use in the fields of radio astronomy, tropospheric scatter propagation, tracking, and experimental test installations. The mount was also designed by ASI, and features azimuth and elevation adjustments at the foot plates where they can be easily reached.



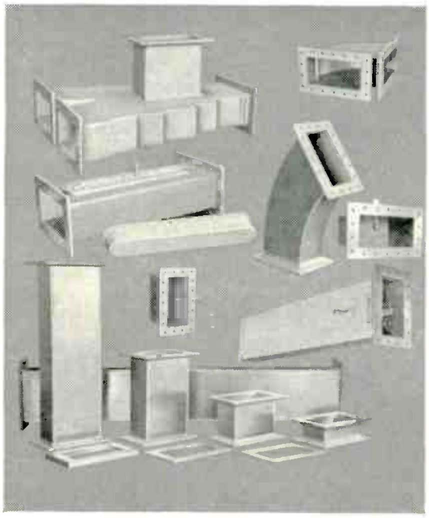
This is the most accurate production antenna of comparable size ever built. It's a 30-foot, solid surface dish (Model 103) and boasts a static surface tolerance of ± 0.045 center 15′ diameter, and ± 0.080 outside 15′ diameter. It can be used at frequencies above 10,000 mc, and is rugged enough to withstand 150 mph wind with 4″ of ice. Special models are available with a surface tolerance of ± 0.020 RMS.



This 30-foot mobile scatter antenna (Model 111) is a completely self contained unit mounted on a steel flat bed trailer. It is easy to assemble, and can be erected by a winch or a hydraulic lifting device. When in transit, all surface panels, hardware, feed supports, guys, etc. nest compactly on the top of the trailer and can be tightly secured in order to withstand transport over rough terrain. The pictures show (1) the antenna completely packed and ready for transit, (2) assembled but not erected, (3) completely erected.



ASI has available as part of their complete antenna service, a wide range of spun parabolic reflectors. This method of metal forming eliminates the use of expensive tools thereby reducing costs and manufacturing time.



ASI's complete line of RF components for many different bands includes straight sections, bends, hybrids, slide screw tuners, dummy loads, transitions, stub tuners, diplexers and feed horns. They are all designed to handle high power with low VSWR, and all flange surfaces are machined after welding to assure excellent electrical contact.

ASI has a complete catalog available that contains specifications on their antennas and antenna components. Also available are a facilities booklet that gives background information about the people and capabilities, and a 20-page booklet of wavelength tables from WR 430 through WR 2300.

For the answers to problems in the design, fabrication, and installation of antennas, antenna components, or complete antenna systems in the fields of scatter communications, missile tracking, space tracking, radar and surveillance, radio astronomy and special antenna projects . . . ASK ASI

ASK

ASI

A S

ANTENNA SYSTEMS INC.

HINGHAM, MASSACHUSETTS

Versatile Enough to "Specialize"

1521-A Graphic Level Recorder . . . $995

At CBS Laboratories,
Stamford, Conn.

General Radio Type 1521-A Graphic Level Recorders serve in three specialized applications:

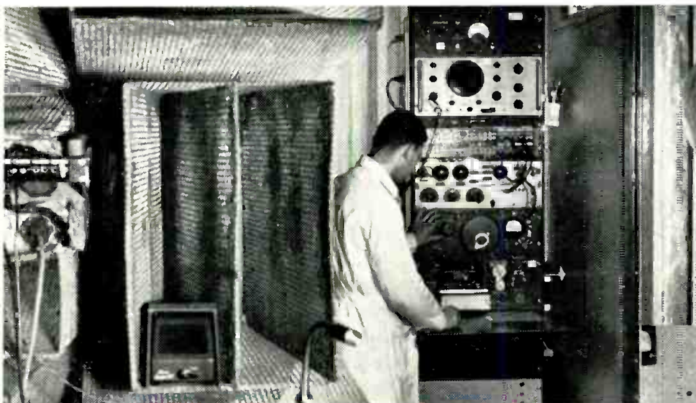
- ★ **Frequency Range:** 20 cps to 200 kc for level recording; dc recording (with accessory d-c pot), dc to 10 cps.
- ★ **Recording Range:** 0 to 40 db (20-db and 80-db pots available as accessories); 0 to 0.8 v with d-c pot.
- ★ **Input Sensitivity:** 1 mv (corresponds to 0 db). Can be varied from 1 mv to 1 v in steps of 10 db with 60-db input attenuator.
- ★ **Accuracy:** ±1% of full scale.
- ★ **Input Impedance:** 10,000 ohms as ac level recorder, 1000 ohms as dc recorder.
- ★ **Pen Writing Speed:** 20 in/sec (200 db/sec) max. with 40-db pot with less than 1 db overshoot. Slower speeds (1, 3, or 10 in/sec) selectable by switch to provide mechanical filtering of rapidly fluctuating levels.
- ★ **Paper Speed:** 2.5 to 75 in/min; slow-speed model available with speeds from 2.5 to 75 in/hr.
- ★ **Price:** $995 with 40-db pot. (accessory 20-db and d-c pots $55 each; 80-db pot $155)

Accessories Needed for Frequency Response Recording

Type 1304-B Beat-Frequency Generator, $680 . . . Couples to recorder for completely automatic response recording

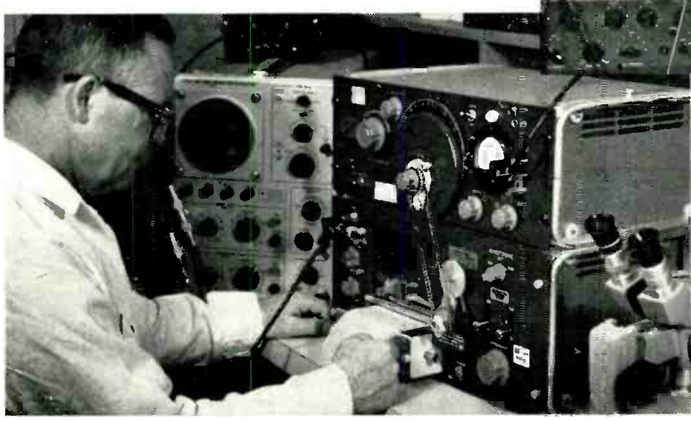
Type 1521-P10 Drive Unit, $72 . . .
Power take off from Recorder to drive generator

Type 1521-P11 Link Unit, $18 . . .
Couples Drive Unit to Generator



▲ **ANECHOIC-CHAMBER INVESTIGATIONS** CBS Laboratories finds the 1521-A Recorder and 1304-B Generator combination indispensable for anechoic chamber investigations of microphones, amplifiers, and other acoustical equipment. With this system, frequency response curves over the full audio range can be made in less than a minute.

▲ **EQUALIZER NETWORK MEASUREMENTS** 1521-A Recorder chain-coupled to a G-R 1304-A Beat-Frequency Generator records the frequency response of equalizer networks. The chain coupling drives the generator's dial in complete synchronism with the recorder to produce a continuous logarithmic response curve. The system is automatic and has far greater accuracy than methods requiring meter watching and point-by-point plotting.



◀ **RECORDING-HEAD RESPONSE CHECKS** Detailed frequency-response characteristics of magnetic recording heads are obtained quickly with the G-R Graphic Level Recorder. The measurement involves the use of a series of wavelength dependent nulls which are a function of the effective gap of the recording head.

Photos Courtesy of CBS Laboratories, A Division of Columbia Broadcasting Systems, Inc.

Write for Complete Information

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

NEW YORK, WOrth 4-2722 District Office in Ridgefield, N. J. WHitney 3-3140	CHICAGO Oak Park Village 8-9400	PHILADELPHIA Abington HAncock 4-7419	WASHINGTON, D. C. Silver Spring JUniper 5-1088	SYRACUSE Syracuse GLenview 4-9323	SAN FRANCISCO Los Altos WHitecliff 8-8233	LOS ANGELES Los Angeles HOllywood 9-6201	ORLANDO, FLA. Orlando GArden 5-4671	IN CANADA Toronto CHerry 6-2171

Circle 43 on Inquiry Card

Letters to the Editor

(*Continued from page* 60)

Survey of Thin Films

Editor, ELECTRONIC INDUSTRIES:

I have read your article "A Survey of Thin Film Technology" in the September issue of ELECTRONIC INDUSTRIES with some degree of interest. Although your second part has not yet been published, your introduction indicates that you are seemingly unaware of several important processes that are part of the thin film technology.

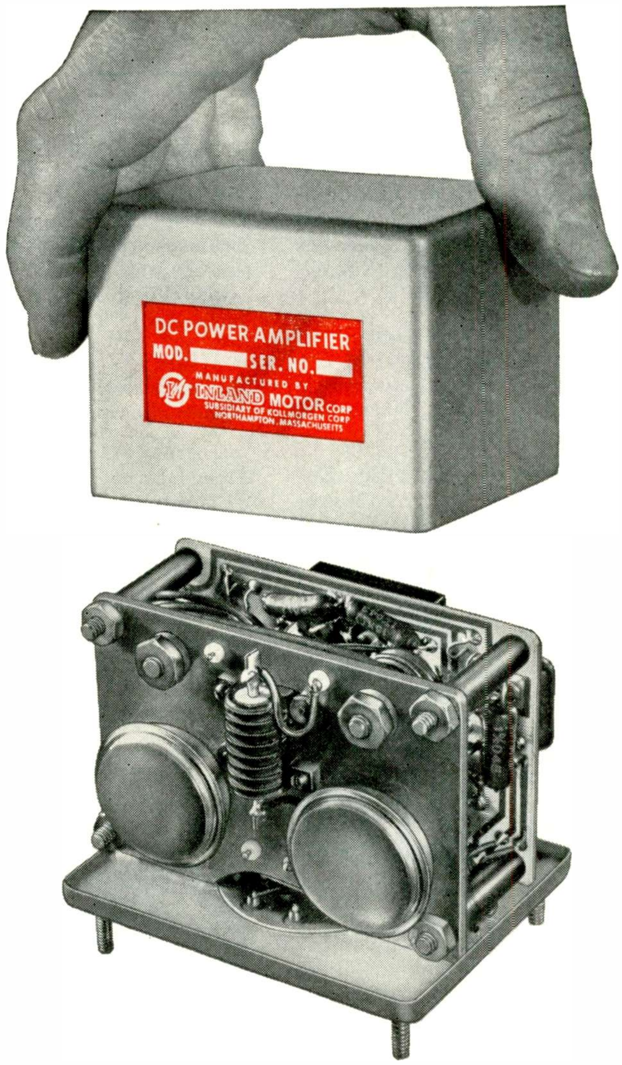
First, there is no material that is too refractory for evaporation by electron bombardment techniques. This type of an evaporator is extremely simple and would in no case be termed elaborate. Pictures of a relative simple electron bombardment evaporator and the vacuum system with which it is used is enclosed for your information. We find sputtering is not mandatory for the deposition of refractory materials and we are not alone in the use of this process.

Secondly, chemical processes for the fabrication of thin film circuits have been shown to be relatively economical of costs and capital equipment. The Microsystems Electronics Department of the Lockheed Missile and Space Co. has developed chemical processes for the fabrication of thin film circuits from titanium. This refractory material was selected and the processes were developed to meet the requirements of the Aerospace Industry with respect to reliability, producibility, size and weight reduction and competitive costs. This program is in the pilot plant development phase and the initial requirements are being fulfilled.

There is enclosed for your information a copy of the paper on Titanium Thin Film Circuits that will be presented at NEC in Chicago in October 1961. This is just one of the many papers that have been prepared by members of the MSE Department that range from reports on the "evolution of electronics" through electroluminescense, electron beam processes, and refractory semiconductors, that have been presented at technical meetings.

Distributed parameter RC networks for thin films circuits are also one of the important parts of the thin film technology, and this part has been the subject of intensive study within the MSE Department.

W. D. Fuller
Manager, Microsystems Electronics
Lockheed Aircraft Corp.
Missile & Space Div.
Sunnyvale, Calif.



INLAND

first with solid state 100-watt d-c amplifier

Inland's new **Model 579.35** d-c amplifier has a high power output of 100 watts when used with low impedance loads requiring direct current. And this completely transistorized amplifier is packaged in a hermetically sealed can only **2½″ x 3³⁄₁₆″ x 2½″**.

Designed for use with d-c torquers, in one typical application Model 579.35 provides 65 db power gain between the output of a d-c driver stage and the input terminals of a permanent magnet torque motor. This amplifier has these outstanding performance characteristics:

- The d-c output has magnitude and polarity proportional to the input signal.
- All amplifier circuits use a combination of silicon and germanium transistors (all-silicon models also available).
- Amplifier null and gain are stable and independent of temperature.

Inland also makes a complete line of rotary amplifiers for matched use with Inland's distinctive pancake shape d-c torquers.

A brochure on this new high-power amplifier is available. For your copy and complete data on Inland torquers and amplifiers, write Dept. 8-11.

TYPICAL SPECIFICATIONS

Maximum Power Output, watts (6 ohm load)	100
Power Gain	4,000,000
Current Gain	200,000
Voltage Gain	15
Frequency Response	DC to 1000 cps
Input Impedance, ohms	50,000
Dimensions, inches	2½ wide 3³⁄₁₆ long 2½ high
Operating Temperature Range in °C	minus 50° to plus 50°

INLAND MOTOR

INLAND MOTOR CORPORATION OF VIRGINIA • A SUBSIDIARY OF KOLLMORGEN CORP., NORTHAMPTON, MASS.

Circle 45 on Inquiry Card

Personals

Aerovox Corp., New Bedford, Mass., announces the following appointments: **David Palamountain** — named Director of Quality Control and **Robert W. Orr**—Chief Engineer for High Voltage and Mica Capacitors and Filters.

Dr. Martin E. Dempsey—appointed Supervisor of Advanced Physical Development, Research Dept., Automatic Electric Laboratories, Inc., Northlake, Ill.

Simon Stopek—appointed Sr. Engineer, Semiconductor Div., Microwave Associates, Inc., Burlington, Mass.

S. Stopek

Dr. B. Friedland

Dr. Bernard Friedland—appointed Sr. Staff Consultant, Melpar, Inc., Applied Science Div., Watertown, Mass.

RCA Electron Tube Div., Microwave Tube Operations, announces the following appointments: **Markus Nowogrodzki** — Manager, Product and Equipment Engineering; **Herbert J. Wolkstein**—Manager, Microwave Design and Development; and **Edward J. Homer** — Manager, Microwave Engineering Administration and Data Systems Development.

Fred Carlson—named Sr. Reliability Engineer, Reliability Engineering Dept., International Resistance Co.'s St. Petersburg (Fla.) Div.

Frequency Engineering Laboratory (formerly Frequency Standards), Asbury Park, N. J., announces the following appointments: **Robert E. Williams**—named Manager, Systems Engineering; and **Robert F. Slevin** named Manager, Microwave and Antenna Engineering.

Dr. Jan A. Rajchman — appointed Director of the Computer Research Laboratory, RCA's David Sarnoff Research Center, Princeton, N. J.

Instruments for Industry, Inc., Hicksville, N. Y., has announced the following appointments: **Lawrence I. Algase**—promoted to Director of Engineering; and **Anthony M. Barbella**—promoted to Chief Systems Engineer.

Data Sensors, Inc., Gardena, Calif., announces the following appointments: **Joseph M. De Stefano**—appointed Chief Engineers; **Frank L. Schulte**—appointed Manager, Application Engineering; and **W. V. Young**—appointed Manager, Quality Assurance.

Willis C. Goss—has joined the Technical Staff at Electro-Optical Instruments, Inc., Pasadena, Calif.

Steven M. Sussman — appointed Head of the Communications Theory Laboratory, Melpar Inc., Applied Science Div., Watertown, Mass.

General Electric Co., Missile and Space Vehicle Dept., Phila., Pa., announces the following appointments: **Edward Ray**—Project Manager for Space Power; and **Victor E. Boccelli** Manager of Technical Facilities, Projects Planning and Special Programs Operation.

Comer L. Davies—named Technical Adviser, Instrument Corp. of Florida, Melbourne, Fla.

G. L. Davies

F. W. Harvey

Frank Wood Harvey — named Sr. Member of the Staff of Image Instruments, Inc., Newton, Mass., in the position of Video Systems Engineer.

James Wagner — appointed Chief, Outside Procurement Quality Control, The Garrett Corp., Los Angeles, Calif.

Consolidated Electrodynamics Corp., Data Recorders Div., Pasadena, Calif., announces the following appointments: **John J. Smith** and **Edgar E. Hotchkin**—appointed Assistant Directors of Engineering and **Lewis B. Browder** — named Manager of Advanced Development.

George De Maio—appointed Quality Control Manager, Fairchild Controls Corp., Fairchild Camera and Instrument Corp., Hicksville, L. I., N. Y.

M. Michael Moss—named Director of Reliability, Radio Receptor Co., Inc., sub. General Instrument Corp., Westbury, L. I., N. Y.

J. E. Kalfus—appointed Chief Engineer, Essex Electronics of Canada Ltd., Div. Nytronics, Inc., Berkeley Heights, N. J.

BENDIX 25-AMP DAP'S!

Bendix® 25-amp DAP (Diffused Alloy Power) transistors are designed for high-temperature, high-current, microsecond switching. They're 'Dynamically Tested', an exclusive Bendix quality control process that tests each unit to assure uniform reliability. In addition to their high current switching capabilities (typically 25 amperes in 4 μsec) Bendix 25-amp DAP® offers circuit stability over a wide range of temperatures (from −60°C to +110°C). They're rated at high collector-to-emitter breakdown voltages, provide low input resistance, controlled current gain, and low saturation voltage. Write to Holmdel, N. J., for details.

Absolute Maximum Ratings:	V_{CE} Vdc	V_{CB} Vdc	I_C Adc	P_C* W	T_{stg} °C	T_j °C
2N1651	60	60	25	100	−60 to +110	110
2N1652	100	100	25	100	−60 to +110	110
2N1653	120	120	25	100	−60 to +110	110

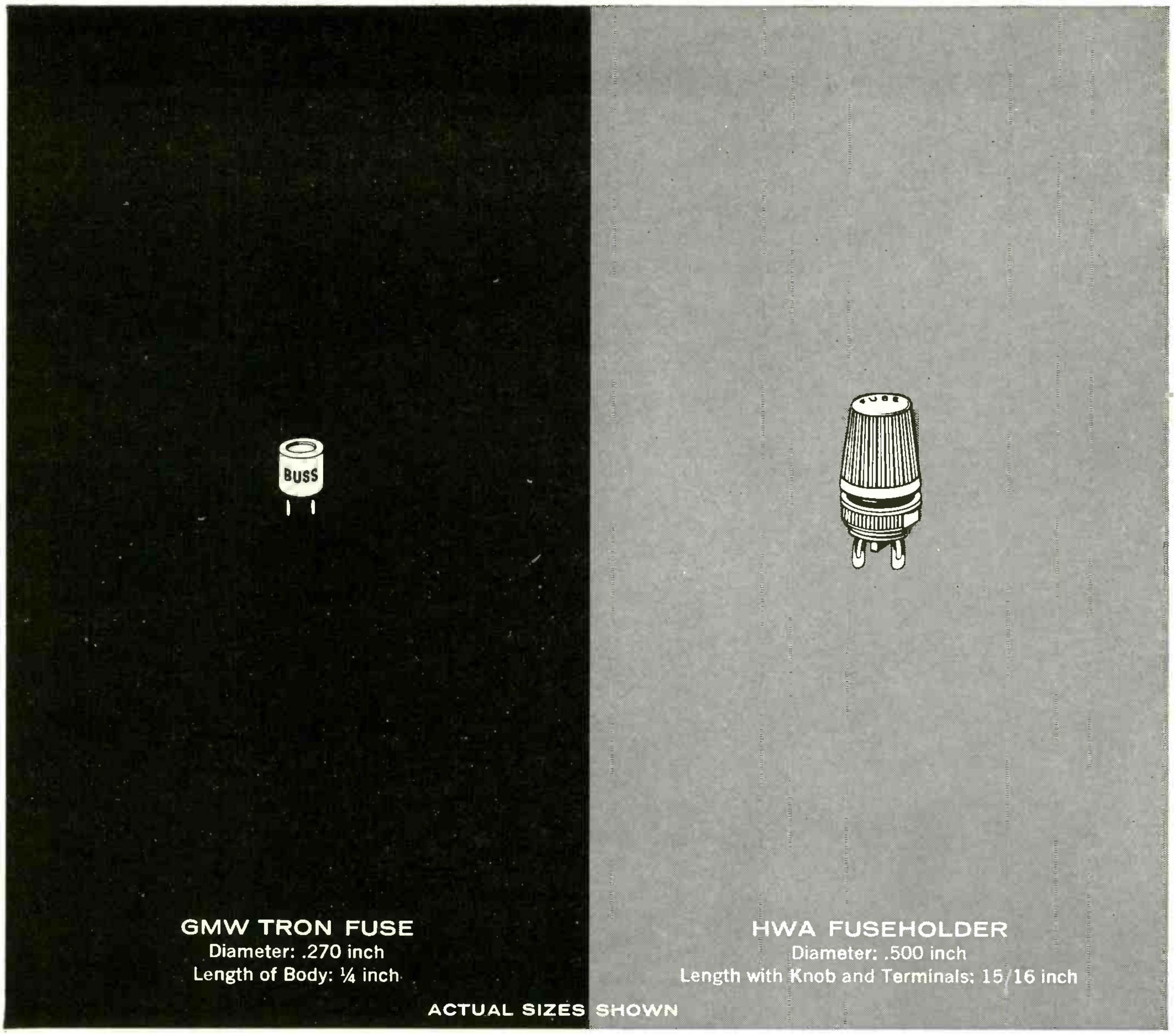
*P_C is the maximum average power dissipation. It can be exceeded during the switching time.

Bendix Semiconductor Division

THE Bendix CORPORATION

Main Office: South St., Holmdel, N. J.—Ph: SH 7-5400 • **New England Office:** 114 Waltham, Lexington, Mass.—Ph: VO 2-7650 • **Detroit Office:** 12950 W. 8 Mile Rd., Detroit 37, Mich.—Ph: JO 6-1420 • **Midwest Office:** 2N565 York Rd., Elmhurst, Ill.—Ph: BR 9-5050 • **West Coast Office:** 117 E. Providencia Ave., Burbank, Calif.—Ph: VI 9-3961 • **Canadian Affiliate:** Computing Devices of Canada, P.O. Box 508, Ottawa 4, Ont. • **Export Office:** Bendix International, 205 E. 42nd Street, New York 17, N.Y. **Stocking Distributor:** Contact nearest sales office for name of local distributor.

Circle 46 on Inquiry Card



Another BUSS sub-miniature fuse and holder combination

EXTREME RELIABILITY UNDER HIGH SHOCK AND SEVERE ENVIRONMENTAL CONDITIONS.

Rigid construction of fuse and holder assures extraordinary reliability under high shock and vibration conditions. Fully insulated ceramic body isolates fusible element from effect of dust, corrosion, moisture and vapors.

DESIGNED FOR SPACE-TIGHT APPLICATIONS

Panel Mounted. Holder can be mounted on panel by hand. No special tool required to run down holding nut.

Prong type contacts on fuse make it easy to install or replace.

A knob for the holder may be used to make holder water proof from front of panel.

HOLDER CAN BE MOUNTED IN PRINTED CIRCUITS

Terminals of holder can be inserted into holes and soldered on printed circuit board without additional forming.

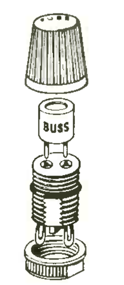
If desired, GMW fuse may be used without holder and mounted directly into printed circuit boards.

AVAILABLE RATINGS FOR GMW FUSES.

Fuses are made in sizes from 1/10 to 5 amperes for use on circuits of 125 volts or less where fault current does not exceed 50 amperes.

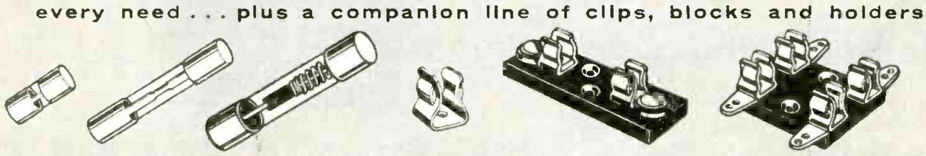
Transparent window in end of fuse body permits visual inspection of fusible element.

Before crystallizing your design using sub-miniature fuses be sure to get full data on the Buss GMW fuse and HWA holder combination.



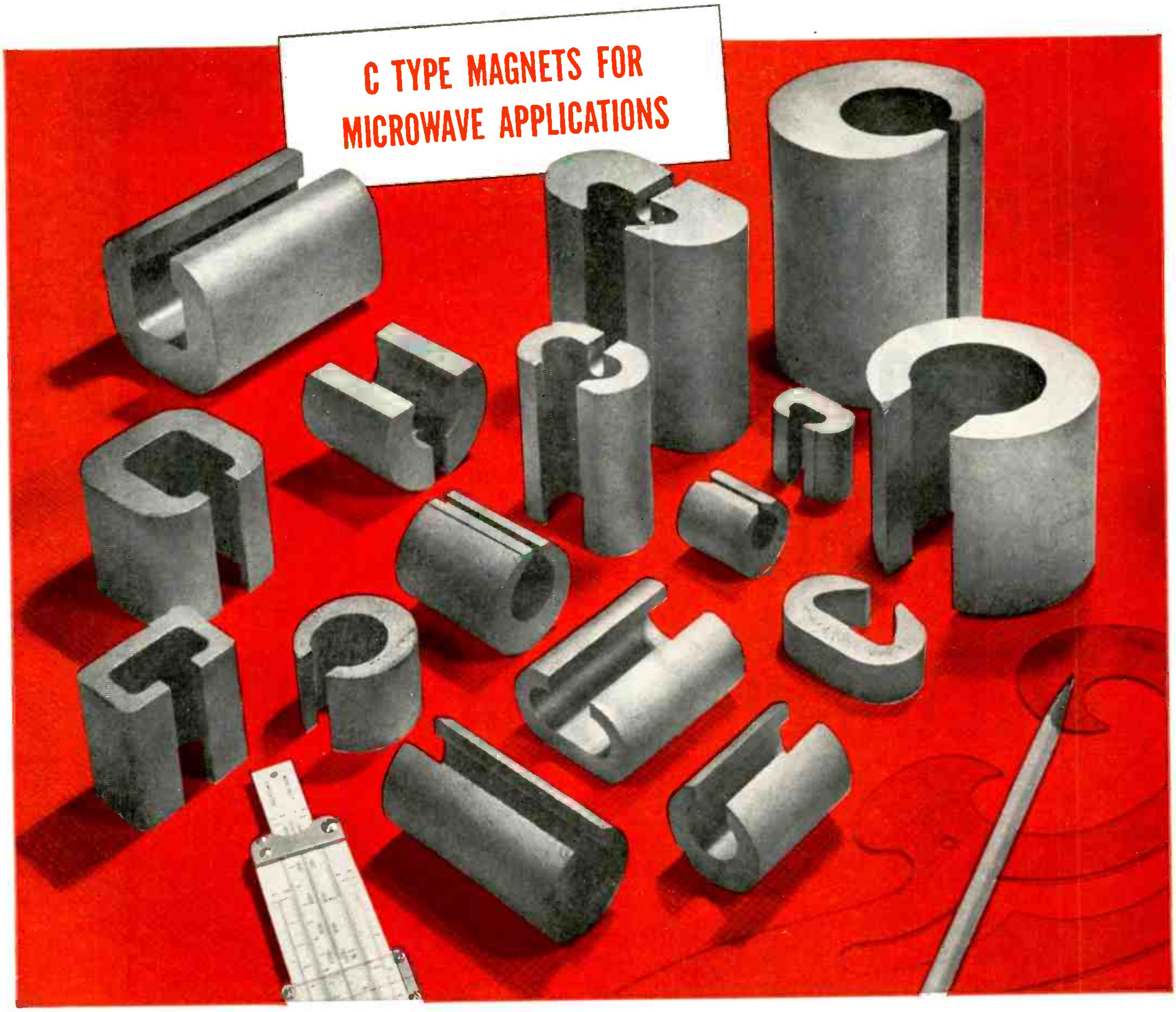
Exploded view of GMW-HWA fuse & holder combination.

IN THE BUSS LINE, you'll find the type and size fuse to fit your every need . . . plus a companion line of clips, blocks and holders.



FUSETRON · TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION · BUSS · McGRAW-EDISON

BUSSMANN MFG. DIVISION, *McGraw-Edison Co.,* UNIVERSITY AT JEFFERSON, ST. LOUIS 7, MO.



C TYPE MAGNETS in a wide range of sizes to meet your design needs in
★ Transverse Field Isolators ★ Differential Phase Shifters ★ Duplexers

Arnold C-type Alnico Magnets are available in a wide selection of gap densities ranging from 1,000 to over 7,500 gausses. There are six different basic configurations with a wide range of stock sizes in each group.

The over-all size and gap density requirements of many prototype designs can be met with stock sizes of Arnold C Magnets, or readily supplied in production quantities.

When used in transverse field isolators, Arnold C Magnets supply the magnetizing field to bias the ferrite into the region of resonance, thus preventing interaction between microwave networks and isolating the receiver from the transmitter. These magnets are also used in differential phase shifters and duplexers, and Arnold is prepared to design and supply tubular magnets to provide axial fields in circular wave guides.

A feature of all Arnold C Magnets is the excellent field uniformity along the length of the magnet. Versatility in design may be realized by using multiple lengths of the same size magnet stacked to accomplish the needs of your magnetic structure.

Let us work with you on any requirement for permanent magnets, tape cores or powder cores. ● For information on Arnold C Magnets, write for Bulletin PM-115. Address *The Arnold Engineering Company, Marengo, Illinois.*

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SPECIALISTS in MAGNETIC MATERIALS

BRANCH OFFICES and REPRESENTATIVES in PRINCIPAL CITIES
Find them FAST in the YELLOW PAGES

Circle 48 on Inquiry Card

Special Pliers for the Highly Specialized Electronics Field

When the early transmission lines were strung in this country a century ago, it was Klein Pliers in the hands of linemen that helped do the job.

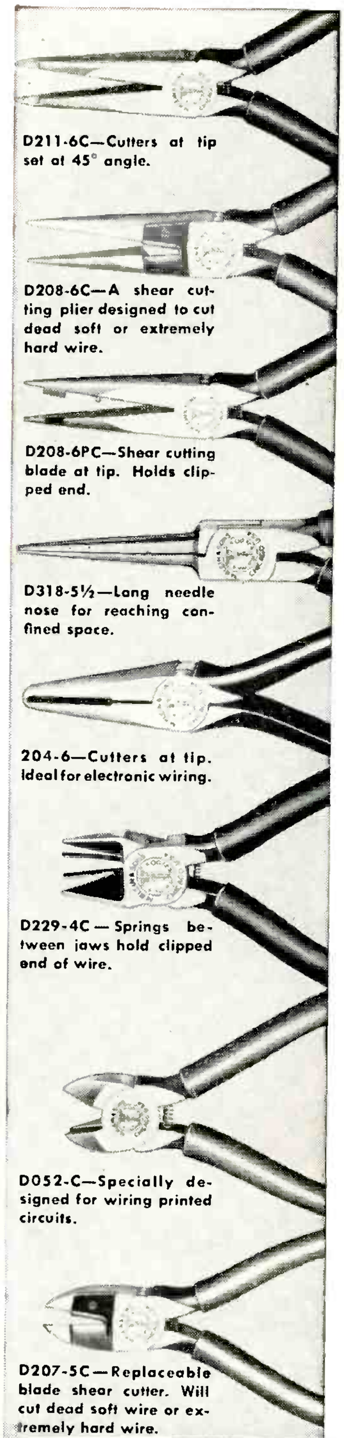
Klein has kept pace with the development of the electrical field, meeting each new challenge with tools specially designed to do the wiring job better . . . more economically.

Shown here are a few of the many highly specialized Klein Pliers carried in stock to meet the needs of electrical and electronics manufacturers.

You will find your assemblies go together more smoothly and wiring is done more rapidly when the right Klein Plier is used.

SEE US AT THE
NEREM MEETING, BOOTH 1712

SEE YOUR DISTRIBUTOR



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Mathias Klein & Sons, Inc. 7200 McCormick Road, Chicago 45, Ill.
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LOW COST / SILICON

2N957

Fairchild Industrial Transistor for

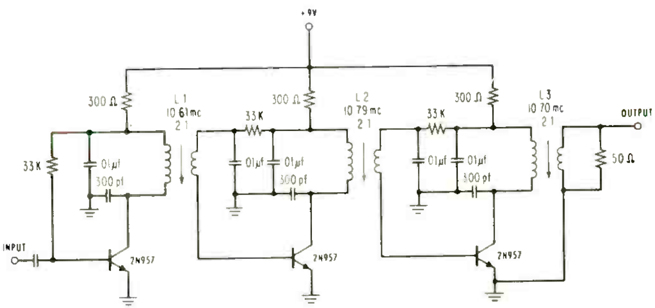
- **VHF AND IF AMPLIFIERS**
- **OSCILLATORS**
- **MIXERS AND CONVERTERS**
- **HIGH SPEED SWITCHING CIRCUITS**

FAST SWITCHING—HIGH FREQUENCY—200 mc GAIN BANDWIDTH

First low cost, high frequency NPN silicon transistor on the industrial market, the Fairchild 2N957 is rated at 0.8 watts (25° C case temperature) and 0.3 watts (100° C case temperature). Guaranteed parameters include: BV_{CBO} of 40 volts; BV_{CEO} of 30 volts; BV_{EBO} of 3.0 volts; minimum D.C. Beta of 45; minimum A.C. Beta at 1 mc of 40; maximum C_{ob} of 6.0 $\mu\mu$f.

The Fairchild 2N957 offers silicon performance–higher reliability, broad temperature range, parameter stability–at low cost. This enables you to build amplifiers, oscillators, mixers, converters, and switching circuits with silicon advantages at no price premium. Contact your Fairchild Distributor or sales office for off-the-shelf delivery.

A 2N957 APPLICATION:
10.7 MC, STAGGERED, TRIPLE TUNED IF AMPLIFIER FOR F.M.



FAIRCHILD SEMICONDUCTOR

545 WHISMAN ROAD, MOUNTAIN VIEW, CALIF. · YORKSHIRE 8-8161 · TWX: MN VW CAL 853
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

Circle 50 on Inquiry Card

Books

ASM Metals Handbook, 8th Edition, Vol. 1— Properties and Selection of Metals

By 1335 Metals Specialists. Edited by Taylor Lyman. Published 1961 by the American Society for Metals, Metals Park, Novelty, Ohio. 1300 pages. Price $30.00.

This volume of the new ASM Metals Handbook is a complete presentation in istelf on the properties and selection of all metals. It is the first volume of a projected series, each volume of which, when completed, will serve as a complete and comprehensive tributary to the mainstream of present knowledge of metals and metalworking.

The Handbook devotes a series of articles to magnetic, electrical and other special purpose materials. In addition to its through coverage of permanent magnet and magnetically soft materials, expert coverage is provided the electrical resistance alloys for instruments and controls, as well as electrical contact materials. Other conventional electrical materials, such as copper, aluminum and certain of the precious and pure metals, have been expanded into separate sections of this reference.

Compared to the previous edition, the new Metals Handbook offers nearly six times as much numerical information, as distinguished from descriptive text, in the form of charts, graphs and tables, on properties and selection. A completely cross-referenced 64 page index makes information searching easier and less time-consuming.

Semiconductor-Diode Parametric Amplifiers

By L. A. Blackwell & K. L. Kotzebue. Published 1961 by Prentice-Hall, Inc., Englewood Cliffs, N. J. 191 pages. Price $9.00.

This book is a theoretical treatment of the major types of parametric devices, aimed at showing the design engineer how and why parametric amplifiers work, and when they can be used to best advantage.

Beginning with the general energy transfer properties of nonlinear reactances, the authors develop the basic theory of the principal types of parametric amplifiers and harmonic generators. Although the semiconductor-diode type is currently the most popular form of parametric amplifier, the book presents many concepts that go beyond the boundry of diode devices. Since the low-noise characteristics of parametric amplifiers account for their current popularity, the authors devote extensive coverage to noise and its effect on system performance. Design considerations are discussed, and several examples of actual microwave hardware are given

(*Continued on page* 76)

New Bourns Precision Potentiometer Resolves the Quality-Price Dilemma!

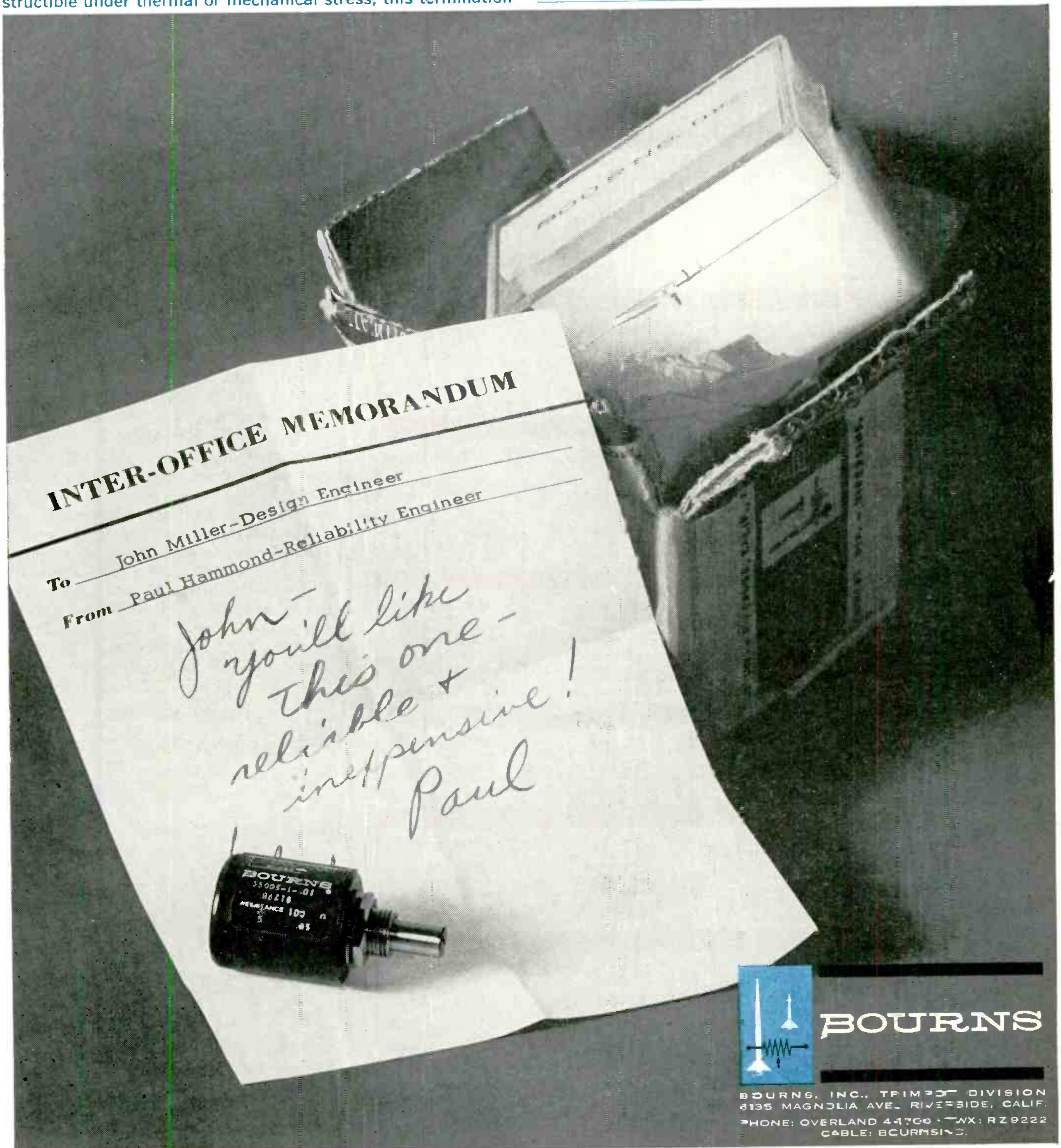
Here is military reliability in a competitively-priced industrial potentiometer. Bourns wirewound 10-turn Model 3500 measures just ⅞" in diameter by 1" long—shorter by ½" than units available elsewhere—yet has a resistance element 20% longer than that of comparable potentiometers.

Fully meeting military requirements for steady-state humidity, Model 3500 can also be provided at a 10% premium to meet the cycling humidity specs of MIL-STD-202, Method 106. It's the only ⅞" 10-turn potentiometer guaranteed to meet this spec. Its published characteristics incorporate wide safety margins.

Reliability insurance is provided by the exclusive Bourns Silverweld® bond between terminal and resistance wire. Virtually indestructible under thermal or mechanical stress, this termination eliminates a chief cause of potentiometer failure. In addition, a special close-tolerance rotor almost completely does away with backlash.

Model 3500 is also subjected to the rigorous double-check of Bourns' exclusive Reliability Assurance Program. In short, every possible step is taken to ensure that the performance you specify is the performance you get. Write for complete data.

Resistances	500Ω to 125K, ±3%, std. (to 250K spl.)
Linearity	±0.25% std.
Power rating	2w at 70°C
Operating temp.	−65° to +125°C
Mech. life	2,000,000 shaft revolutions



Manufacturer: Trimpot® potentiometers; transducers for position, pressure, acceleration. Plants: Riverside, California; Ames, Iowa; and Toronto, Canada

Circle 54 on Inquiry Card

Books

(Continued from page 72)

Advanced Calculus, 2nd Edition

By David V. Widder. Published 1961 by Prentice-Hall, Inc., Englewood Cliffs, N. J. 520 pages. Price $12.00.

In this revision, the author has retained the best features of the original edition and has made many improvements. Advanced Calculus is especially designed for the reader who has some familiarity with the manipulations of elementary calculus and wishes to advance into the theoretical aspects of the subject. To aid this progression, the author emphasizes first the type of manipulative problems the reader has been accustomed to, and gradually proceeds to more theoretic problems. Readers grasp ideas quickly because they are presented in the form of precise statements.

Electronic Radio and Microwave Physics

By D. E. Clark & H. J. Mead. Published 1961 by The MacMillan Co., 60 Fifth Ave., New York 11, N. Y. 521 pages. Price $25.00.

A reference work for experienced technicians and for teachers in the fields of physics and electronic engineering, and a primary textbook for students in those fields. Book is divided into fifteen chapters:

Mathematical Introduction; Principles of Electromagnetic Theory; Transmission Lines; Waveguides; Spectroscopy at Radio and Microwave Frequencies; Properties of Dielectrics and Ferrites; Radiation and Propagation of Electromagnetic Waves; Artificial Lines and Filters; Thermionic Emission and Thermionic Valves; Amplification and the Single Stage Amplifier; Multi-Stage Amplifier; Oscillators; High Frequency Systems and Klystrons; Traveling Wave Tubes and Magnetrons; Noise.

Books Received

ABC's of Model Radio Control

By Allan Lytel. Published 1961 by Howard W. Sams & Co., Inc., 2201 East 46th St., Indianapolis 6, Ind. 96 pages. Price $1.95.

Radio Control Manual

By Edward L. Safford, Jr. Published 1961 by Gernsback Library, Inc., 154 West 14th Street, New York 11, N. Y. 192 pages. Paperbound. Price $3.20.

First-Class Radiotelephone License Handbook

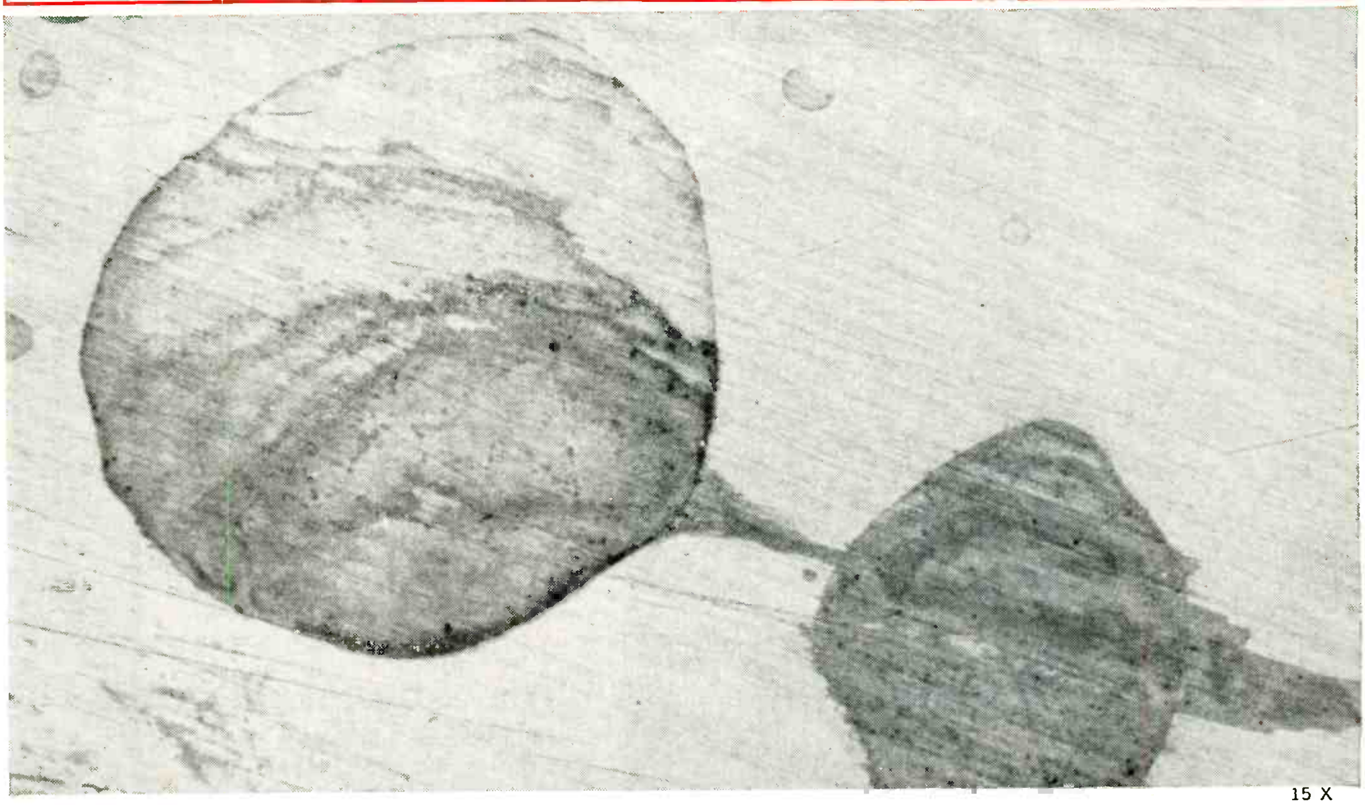
By Edward M. Noll. Published 1961 by Howard W. Sams & Co., Inc., 2201 E. 46th St., Indianapolis 6, Indiana. 304 pages. Paperbound. Price $4.95.

Essentials of Radio-Electronics, Second Edition

By Morris Slurzberg and William Osterheld. Published 1961 by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. 716 pages. Price $10.00.

(Continued on page 82)

Where even a water mark can cause trouble, **ultrasonic cleaning** makes the crucial difference...



15 X

and in ultrasonic cleaners—

GENESOLV® D FLUOROCARBON SOLVENT

can make the clean difference!

Ultrasonic cleaning is only as good as the solvent you use! In critical precision guidance and electronic components, foreign matter 1/40th the diameter of a human hair can cause malfunction. Fingerprints, water marks, specks of dust, lint, epidermis and many other contaminants are potential trouble makers. Your ultrasonic cleaning material must itself be super clean . . . and effective against a wide range of contaminants, while non-injurious to the parent material.

GENESOLV D Fluorocarbon Solvent offers the exceptional purity you need . . . plus these other specific advantages in ultrasonic cleaning operations:

- ✔ *extremely low undissolved and dissolved residue*
- ✔ *selectivity*
- ✔ *low toxicity*
- ✔ *nonflammability*
- ✔ *low surface tension (increased wettability, with minimum dragout)*
- ✔ *quick drying*

Find out now about GENESOLV D's special effectiveness. Our Technical Service constantly is developing new data, and would be pleased to work with you on your cleaning problems. Write or phone your nearest General Chemical Office.

Allied Chemical

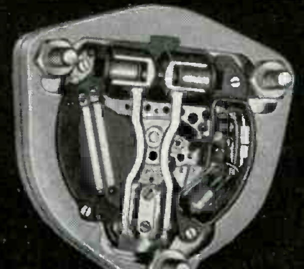
GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N.Y.

Circle 56 on Inquiry Card

FREQ. STDS.

AND TUNING FORK OSCILLATORS

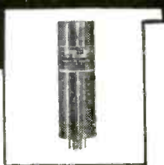
TYPE 10, ACTUAL SIZE



SIZE, 1-3/8" x 1-3/8" x 3/8"

This frequency standard (360 or 400 cy.) is accurate to ± 25 parts per million at 10° to 35°C. The tuning fork is made from Iso-elastic alloy and is approximately 1 inch long. Fork aging has been greatly minimized. Compensation in the circuit provides a minimum rate change throughout the useful life of the power cell (over a year). External power of 1.4 volts at approximately 6 microamperes can also power the unit. An hermetically sealed model, Type 15, is also available.

TYPE 2007



TYPE 15

For more than 20 years, this company has made frequency standards and fork oscillators within the range of 30 to 30,000 cycles for applications where consistent accuracy and rugged dependability are demanded. A few examples are shown and described here.

Some users integrate these units into instruments of their own manufacture. Others rely on our experience and facilities to develop complete operating assemblies to meet their special needs.

You are invited to submit any problems within the area of our activities for study by our engineering staff.

TYPE K-5A FREQUENCY STANDARD

Size, 3½" x 3" x 1¾"
Weight, 1½ lbs.
Frequency: 400 cycles
Accuracy: .03%, —55° to + 71°C
Input: 28V DC ±10%
Output: 400 cy. approx. sq. wave
at 115V into 4000 ohm load (approx. 4W)

TYPE 2007-6 FREQUENCY STANDARD

Transistorized, Silicon type
Size, 1½" dia., x 3½" H., Wt., 7 oz.
Frequencies: 360 to 1000 cy.
Accuracies:
2007-6 ± .02% (—50° to +85°C)
R2007-6 ± .002% (+15° to +35°C)
W2007-6 ± .005% (—65° to +85°C)
Input: 10 to 30V DC at 6 ma.
Output: Multitap, 75 to 100,000 ohms

TYPE 25 PRECISION FORK

Size, ⅝" dia. x 2 3/16"
Weight: 2 ounces
Frequencies: 200 to 1000 cy. (specify)
Accuracies:
R-25T and R-25V ± .002% (15° to 35°C)
25T and 25V ± .02% (—65° to 85°C)
For use with tubes or transistors.

TYPE 15 FREQUENCY STANDARD

Similar to Type 10 (illustrated) except
with silicon transistor, hermetically sealed
and vibration resistant.
Size, 1" x 2" x 2" high
Tolerance, ± .01% from —40°C to + 71°C
Output: .1V at 50,000 ohms source impedance.

ATP INC.

AMERICAN TIME PRODUCTS, INC.

61-20 Woodside Ave., Woodside 77, L.I., N. Y.

New! Sylvania CT4251

First

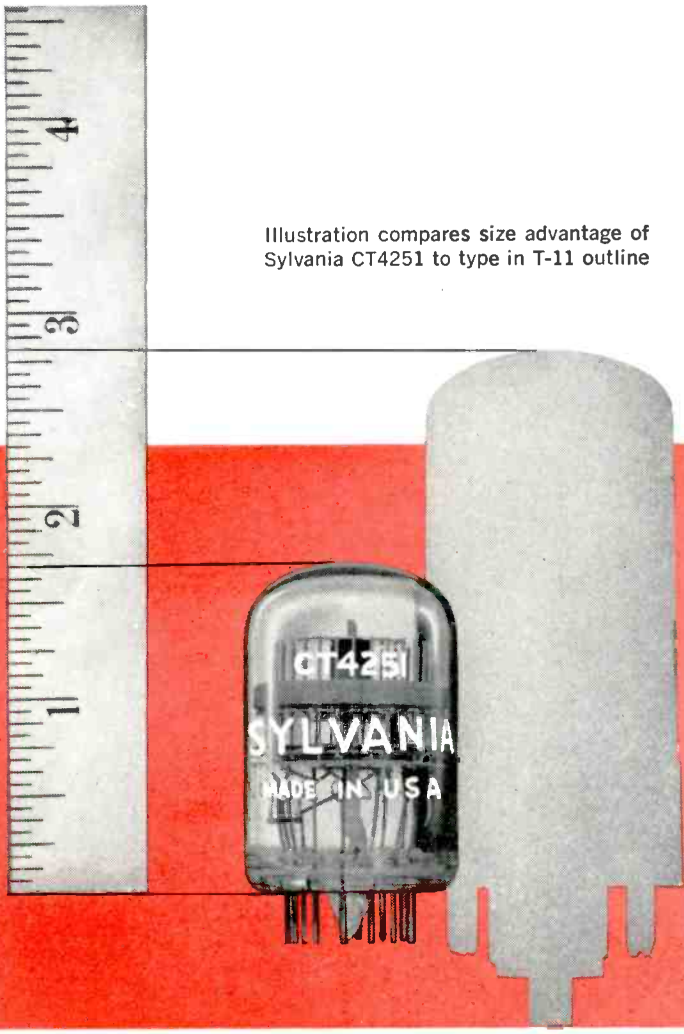
Compact

Decade Counter Tube

in Dome-Shaped T-9 Bulb

with 10 Output Cathodes

Illustration compares size advantage of Sylvania CT4251 to type in T-11 outline



Sylvania introduces the new CT4251 . . . opening a dramatic new approach to the design of very compact, low-cost counting equipment in the 0-50KC frequency range.

Utilizing a new dome-shaped T-9 bulb evacuated from the base, Sylvania CT4251 offers significant reductions in seated height. CT4251 features 10 output cathodes, offering the versatility and advantages of tube types previously available only in the T-11 bulb. Examples: electrical information can be fed from all 10 cathodes, enabling preselection of a count from 0-9; the diameter of the ring of cathodes is identical with that of types in the T-11 outline, providing excellent visibility of readout information.

Sylvania CT4251 is the lowest cost *cold cathode Decade Counter Tube* available. Combining electrical and visual readout functions, it offers extensive economies in circuitry and associated components. Sockets, too, for its 13-pin circle are as much as one-half the cost of sockets normally required for T-11 types. In addition, this new 13-pin circle makes it possible for Sylvania CT4251 to be designed into equipment using transistorized and printed circuit techniques.

Tests to date of Sylvania CT4251 indicate superior quality performance even under stand-by operation for 500 hours.

Your Sylvania Sales Engineer will be pleased to tell you more. Contact him or write Electronic Tubes Division, Sylvania Electric Products Inc., Dept. 1911, 1100 Main St., Buffalo 9, N.Y.

Sylvania Type	Total Anode Current (mA)		Min. Anode Supply Voltage (Vdc)	Min. Double Pulse Amplitude (V)	Min. Double Pulse Width (μsec)
	Min.	Max.			
CT4251	0.65	0.8	400	–70	4

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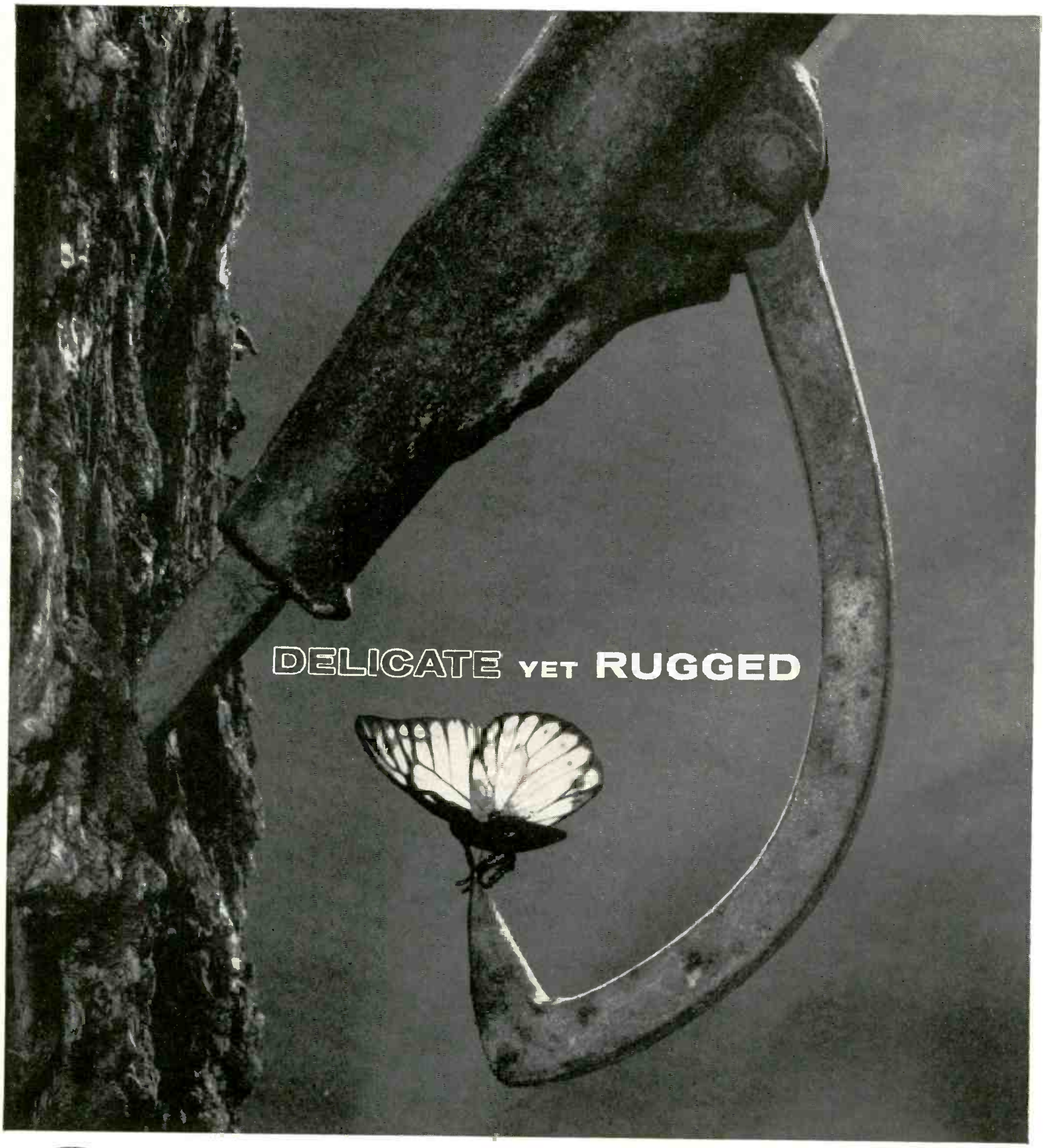
GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM



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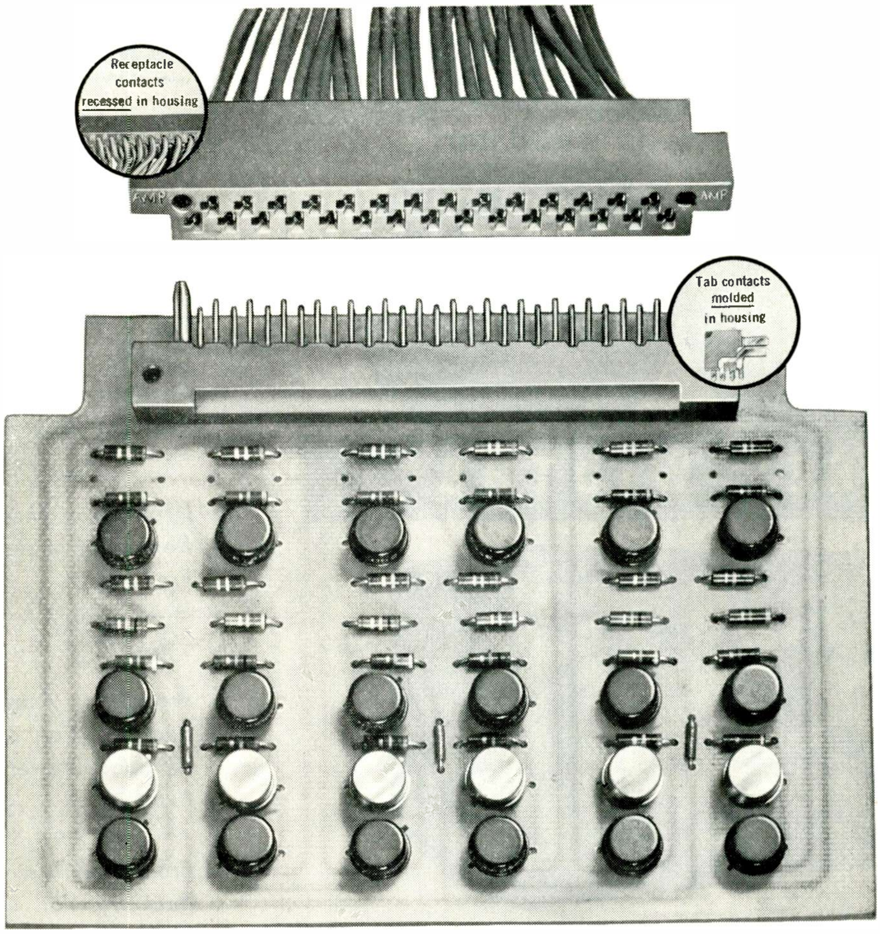

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Books

Crossed-Field Microwave Devices Vol. 1, Principal Elements of Crossed-Field Devices

Published 1961 by Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y. 648 pages. Price $22.00.

Crossed-Field Microwave Devices, Vol. 2, Principal Types of Crossed-Field Devices Analysis of Oscillator System Performance Regional Progress and Trends

Published 1961 by Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y. 520 pages. Price $18.00.

Information Theory, Statistical Decision Functions, Random Processes

Published 1961 by Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y. 843 pages. Price $22.00. Transactions of the Second Prague Conference, June 1-6, 1959, Liblice near Prague.

Progress in Astronautics and Rocketry, Vol. 3, Energy Conversion for Space Power

Edited by N. W. Snyder. Published 1961 by Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y. 779 pages. Price $7.25.

Progress in Astronautics, and Rocketry, Vol. 4, Space Power Systems

Edited by N. W. Snyder. Published 1961 by Academic Press., Inc., 111 Fifth Ave., New York 3, N. Y. 632 pages. Price $6.00.

Progress in Astronautics and Rocketry, Vol. 5, Electrostatic Propulsion

Edited by D. B. Langmuir, E. Stuhlinger & J. M. Sellen, Jr. Published 1961 by Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y. 579 pages. Price $5.75.

Two-way Mobile Radio Maintenance

By Jack Darr. Published 1961 by Howard W. Sams & Co., Inc., 2201 East 46th St., Indianapolis 6, Indiana. 256 pages. Price $4.95.

Troubleshooting Amateur Radio Equipment

By Howard S. Pyle, W7OE. Published 1961 by Howard W. Sams & Co., Inc., 2201 East 46th St., Indianapolis 6, Indiana. 128 pages. Price $2.50.

Servicing Transistor Radios, Vol. 9

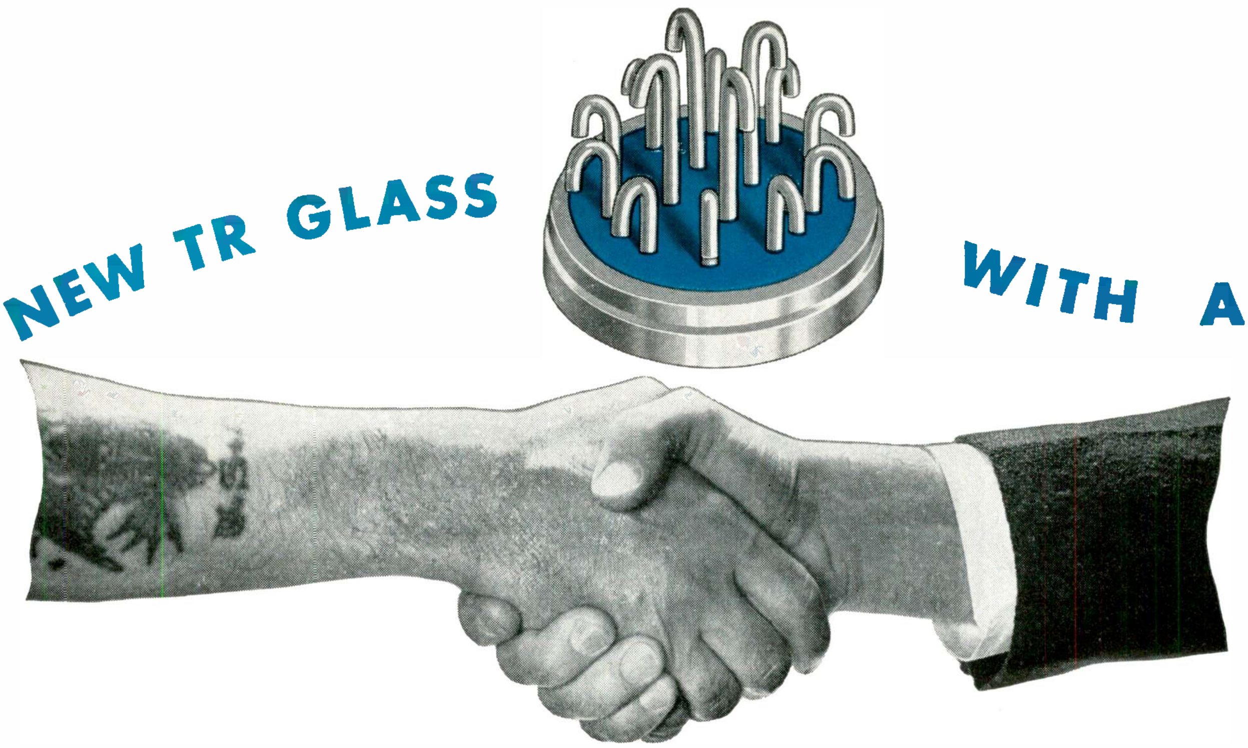
Published 1961 by Howard W. Sams & Co., Inc., 2201 East 46th St., Indianapolis 6, Indiana. 160 pages. Price $2.95.

Basic Electronics Series: Amplifier Circuits

By Thomas M. Adams. Published 1961 by Howard W. Sams & Co., Inc., 2201 East 46th St., Indianapolis 6, Indiana. 136 pages. Price $2.95.

Instruments and Measurements, Vol. 1, Automatic Process Control Physical Methods of Chemical Analysis

Edited by Helge von Koch and Gregory Ljungberg. Published 1961 by Academic Press, Publishers, 111 Fifth Ave., New York 3, N. Y. 506 pages. Price $16.00. Proceedings of the Fifth International Instruments and Measurements Conference, Sept. 13-16, 1960, Stockholm, Sweden.



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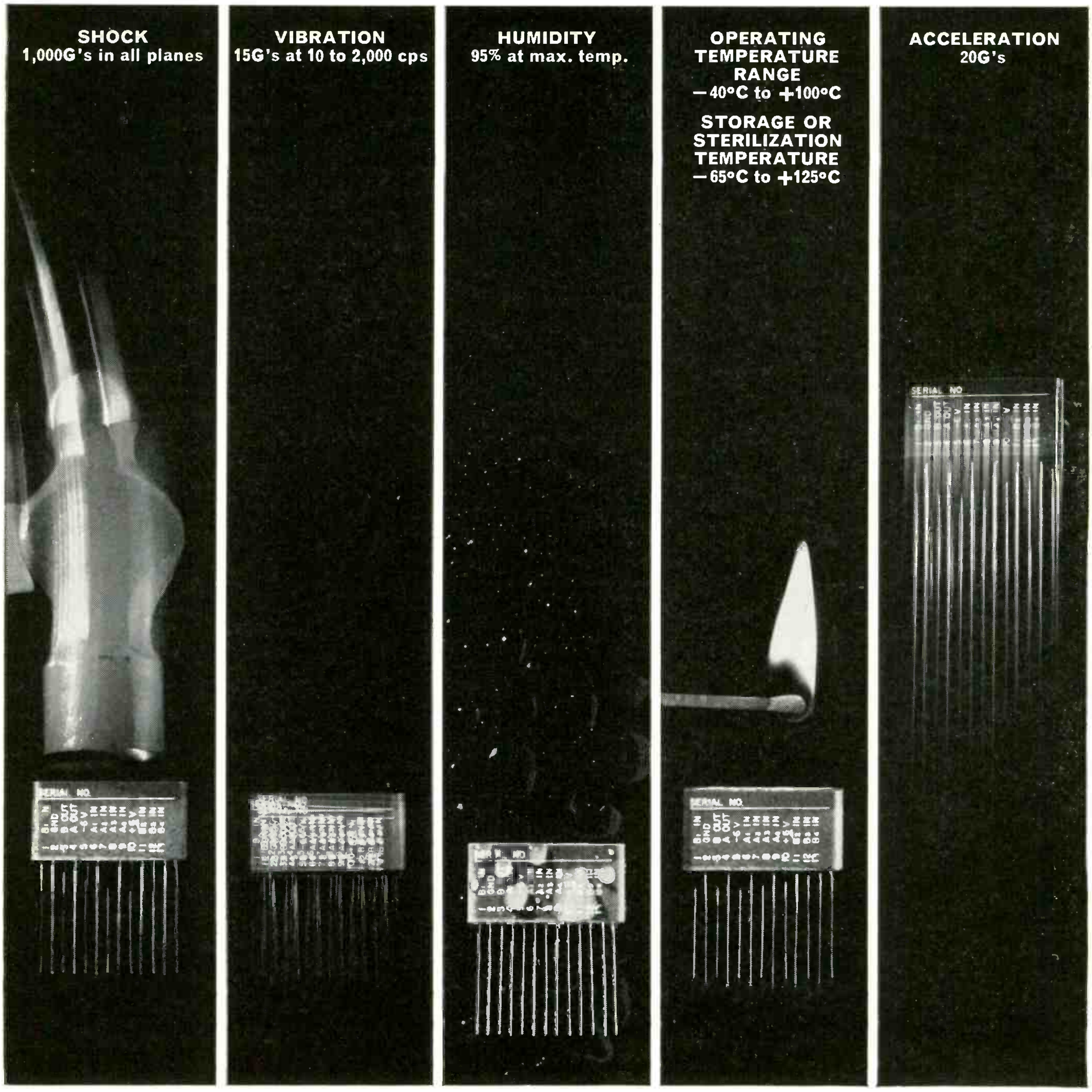

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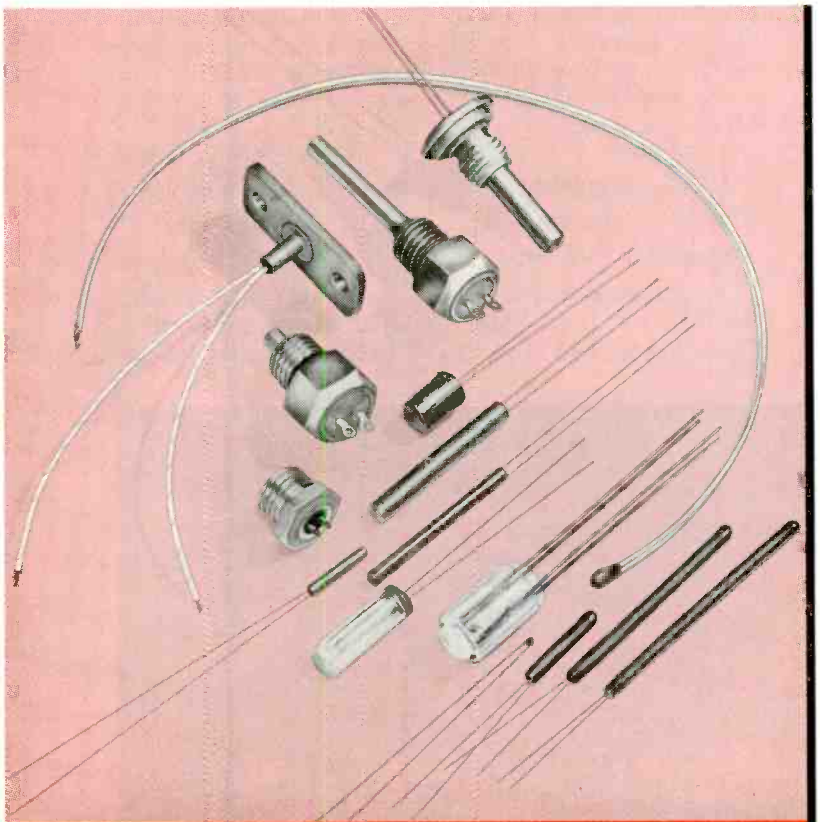
Keystone

BEAD TYPE THERMISTORS



Representative Keystone Bead Type Thermistors
AVAILABLE FROM STOCK

Unit Type	R @ 0°C	R @ 25°C	R @ 37.8°C	R @ 104.4°C
L0503-184-59*	700	280.5	184	31.2
L0503-329-59*	1,252	500	329	55.8
L0503-550-71	2,400	872	550	77.5
L0503-1220-81	6,110	2,010	1,220	150.6
L0503-1500-88	7,940	2,520	1,500	170.5
L0503-2900-76*	13,260	4,680	2,900	381.5
L0503-5K-97	28,300	8,590	5,000	515
L0503-9K-102	52,000	15,600	9,000	882
L0503-16920-112	105,300	30.000	16,920	1,511
L0503-33.3K-125	217,500	60,000	33,300	2,665
L0503-55.3K-125	365,500	100,000	55,300	4,420
L0503-180K-145	1,273,000	333,000	180,000	12,400
L0505-400K-145	2,830,000	740,000	400,000	27,600
L0504-523K-155*	4,060,000	1,000,000	523,000	33,750

*These units processed for operation to 150° C maximum; all others, to 260° C maximum.

***FAST RESPONSE** in temperature measurement...temperature measurement and control...liquid level sensing...*
***PLUS** the most uniform operating characteristics of any bead types known!*

■ Add *versatility* to these Keystone advantages in low power bead-type thermistors—and you have every good reason for making Keystone your key source for thermistor production requirements!

■ The table at left lists basic Keystone units in stock. An almost infinite number of special units can be engineered and furnished to meet your needs. These can be supplied with a wide variety of lead materials to meet your design requirements. Protective coatings, such as glazes, silicone varnishes, durex and cycleweld can be applied, enabling operation in many environmental conditions.

■ Due to the special nature of our production processes, our L0503 and L0505 size units provide more uniform operating characteristics than any bead types previously known.
These types have a basic unit nominal diameter of .050″ and thickness of .030″ and .050″ respectively. Various configurations call out a time constant of approximately 5 seconds and a dissipation constant of 0.62 milliwatts per degree Centigrade.

■ These units can be fabricated in any special configurations, including silver probes, stainless steel probes, glazed ceramic probes, units mounted in headers, on transistor bases, etc.

■ Keystone Bead Type Thermistors are available in close-tolerance patterns. Resistance-temperature tolerances are maintained in regular production within the same tolerance limits as other Keystone types.

■ May we have your requirements?

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These are resistors that are rugged, completely moisture resistant, highly vibration resistant . . . in short, resistors that exceed the requirements of MIL-R-10509C, Char. B, better than any we've seen or heard of.

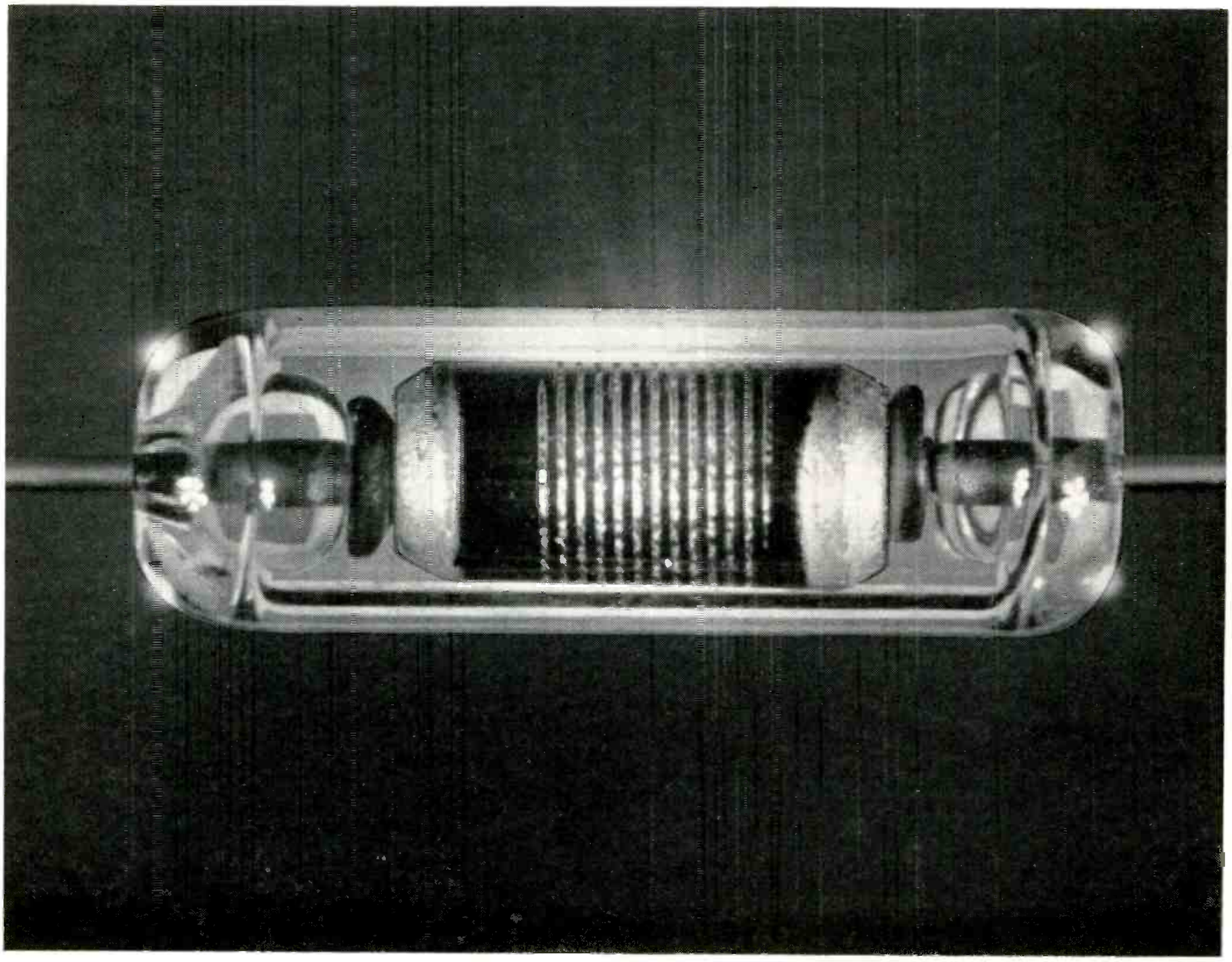
The key to such fortitude is our NF structure. We start with glass rods with metal oxide applied under heat. This in itself makes a moisture-resistant, almost abnormally stable resistor, as you well know if you have ever used our regular N-style resistors.

We encapsulate this basic unit in a glass envelope and apply glass-to-metal seals at the leads . . . comparable to those in a vacuum tube.

IMMEDIATE DELIVERY • There are two models of this gem in production, ready for *quick shipment:* the 1/8-watt NF-60 and the 1/4-watt NF-65. Resistance ranges from 100 ohms to 360K ohms. Voltage ratings are 250v and 300v. Full rating at 70°C. with derating to 150°C. More typical values:

Load life	0.3%
Voltage coefficient	0.001%/v
Temp. coefficient	0.015%/°C
Insulation resistance	100,000 megohms

To get these and other data for your file, just write and ask for Data Sheet CE-2.02. Address: Corning Glass Works, 546 High Street, Bradford, Pennsylvania.



CORNING ELECTRONIC COMPONENTS

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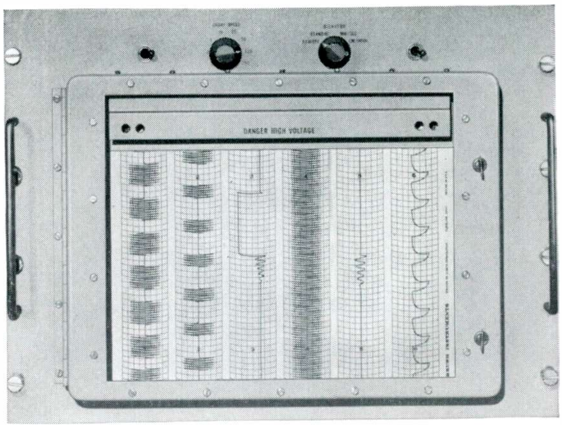

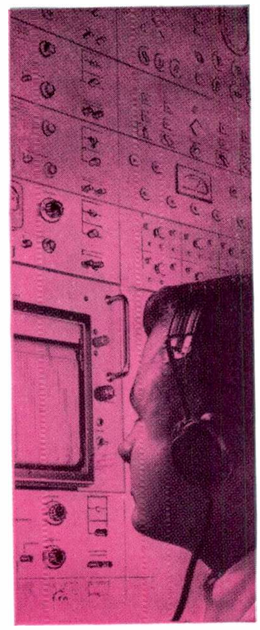

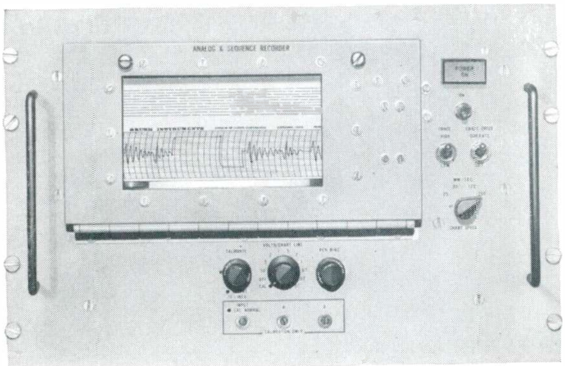

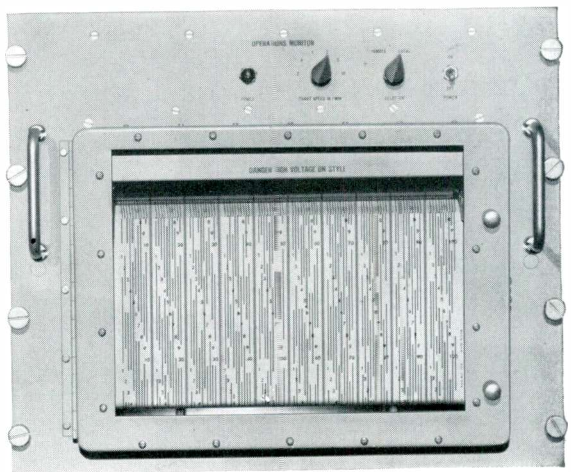

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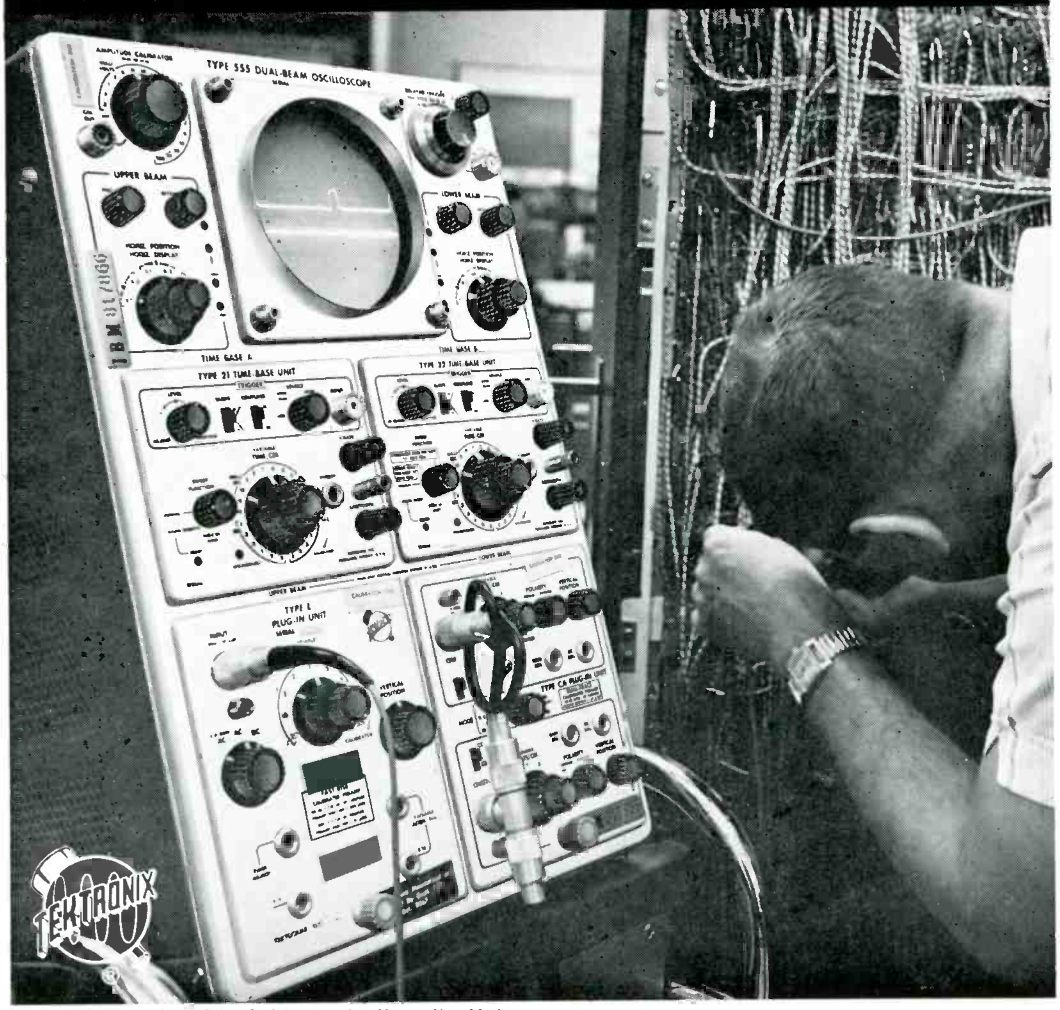
Checking Computer Storage Units

with a

Tektronix Dual-Beam Oscilloscope



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CHARACTERISTICS

Independent X and Y Deflection • DC-to-30 MC, 12-nsec Risetime with Fast-Rise Plug-In Units • 21 Calibrated Sweep Rates from 0.1 μsec/cm to 5 sec/cm • 5X Magnifier • Single-Sweep Provision • Calibrated Sweep Delay • Amplitude-Level (Manual) Selection or Fully Automatic Triggering Facilities • 10-KV Accelerating Potential • 4-cm by 10-cm Display for Each Beam, with 2-cm Overlap • Amplitude Calibrator.

CAPABILITIES

With a Tektronix Type 555 Dual-Beam Oscilloscope, you can control either or both beams with either time-base generator. You can operate one time-base unit as a delay generator—hold off the start of any sweep generated by the other for a precise interval from one-half microsecond to 50 seconds—and observe both the original display and the delayed display at the same time.

By interchanging any combination of 17 letter-series plug-in units, you have signal-handling versatility in such applications as dual-beam pulse-sampling . . . transistor-risetime testing . . . semiconductor-diode-recovery-time studies . . . strain gage and other transducer measurements . . . differential-comparator displays . . . as well as multiple-trace work in general laboratory experiments.

The Type 555 can mean better engineering for you—in less time.

Type 555 .... $2600
(without preamplifiers)

Includes Indicator Unit, Power Unit, 2 Time-Base Units, 4 Probes, Time-Base Extension, 7 other accessories. U.S. Sales Price f.o.b. Beaverton, Ore.

Engineers at the Los Alamos Scientific Laboratory in New Mexico presently use a Tektronix Type 555 Dual-Beam Oscilloscope for checking out the magnetic-core storage units in Stretch, the new high-speed computer. Upper trace is a storage pulse from one of the units. Lower trace is free-running, awaiting the next storage pulse switched in by the computer.

Six of these magnetic-core storage units constitute the basic *memory* of Stretch, reputed to be the world's most powerful computer. The computer *memory* can store 98,304 words of information, equivalent to more than 1,500,000 decimal units—with data retrievable electronically from any unit in approximately 2 microseconds.

Designed and built for the Laboratory by IBM, in co-operation with the Laboratory's Theoretical Division staff members, Stretch permits scientists to work with far more realistic weapons simulations than in the past, and to analyze the vast amount of data gathered during the tests of nuclear rocket propulsion reactors.

For your own scientific tests and measurements—in analyzing waveforms in the dc-to-30 mc range—you will find a Tektronix Type 555 Dual-Beam Oscilloscope extremely adaptable and reliable. You can use it to display almost any signal in almost any laboratory application.

To observe the signal-handling ease and capabilities of this dual-beam oscilloscope in your own laboratory application, **please call your Tektronix Field Engineer. He will gladly arrange a demonstration for you at your convenience.**

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European and African countries, the countries of Lebanon and Turkey, please contact TEKTRONIX INTERNATIONAL A.G., Terrassenweg 1A, Zug, Switzerland, for the name of your local engineering representative.

Other Overseas areas, please write or cable directly to Tektronix, Inc., International Marketing Department, P. O. Box 500, Beaverton, Oregon, U.S.A. Cable: TEKTRONIX.

Next month

ELECTRONIC MATERIALS—NOW AND IN THE FUTURE!

Within just the last two years there has been a new comprehension of the inherent electrical properties of materials. Stemming from the science of solid-state techniques a deeper appreciation of the behavior of the electron and its reactions to its environments is taking place. We now know that it reacts to pressure, strains or molecular and crystalline structures, and that it reacts to temperature changes, or to a degree of light. Research along these lines is creating new families of materials, and paving the way for electronic progress in the coming years.

SURVEY OF LOW-NOISE MICROWAVE AMPLIFIERS

The development of low-noise microwave amplifiers such as the maser and varactor diode parametric devices are opening up new possibilities for military and commercial electronics. This article examines some of the major aspects of this radically new approach.

CONNECTORS AND GALVANIC CORROSION

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

1962 ELECTRONIC SPECTRUM CHART

For well over a decade ELECTRONIC INDUSTRIES has been noted as the source of information on frequency assignments. The colorful EI Frequency Charts are one of industry's most familiar sights, adorning the walls of all major electronic laboratories. This year, the chart is being brought up to date, to include the international frequency agreements determined at the recent Geneva conference, and covering the new high frequency bands.

Plus all other regular departments

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

COMING SOON

VACUUM TUBE VOLTMETERS

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

Companies throughout the industry, both here and abroad, have been queried and have answered. Manufacturers in the United States, Australia, Canada, Denmark, France and Great Britain have contributed to help make this a valuable reference piece.

Watch for these coming issues:

***JANUARY**
Statistical and Annual Industry Review

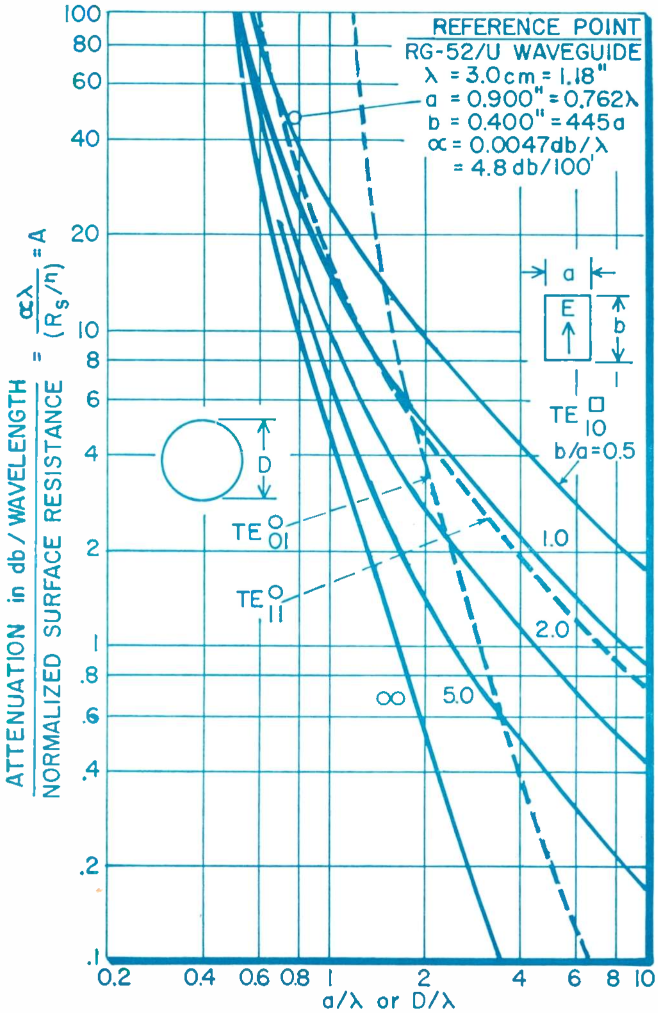
***MARCH**
Annual IRE Issue

***JUNE**
All-Reference Issue

Being a technique, microwaves are useful in many fields of technology, such as radio, physics, and optics. The areas which deserve the most attention, because of growth potential, are high power microwaves and optical masers.

MICROWAVES—

Fig. 1: Normalized attenuation as a function of waveguide dimension. A large reduction in attenuation is possible using oversized rectangular waveguide. The comparative "low-loss" feature of the TE°_{01} mode can be attained when the circular waveguide is significantly oversized.



BECAUSE sources and detectors were relatively easily obtained, the evolution of electromagnetic technology began at the low and extremely high frequency ends of the spectrum.

At the low frequency end, circuit dimensions are small compared to wavelength. The analytical procedures are based on lumped constant elements; and, the engineering entities, such as, voltages and impedances, have unique significance.

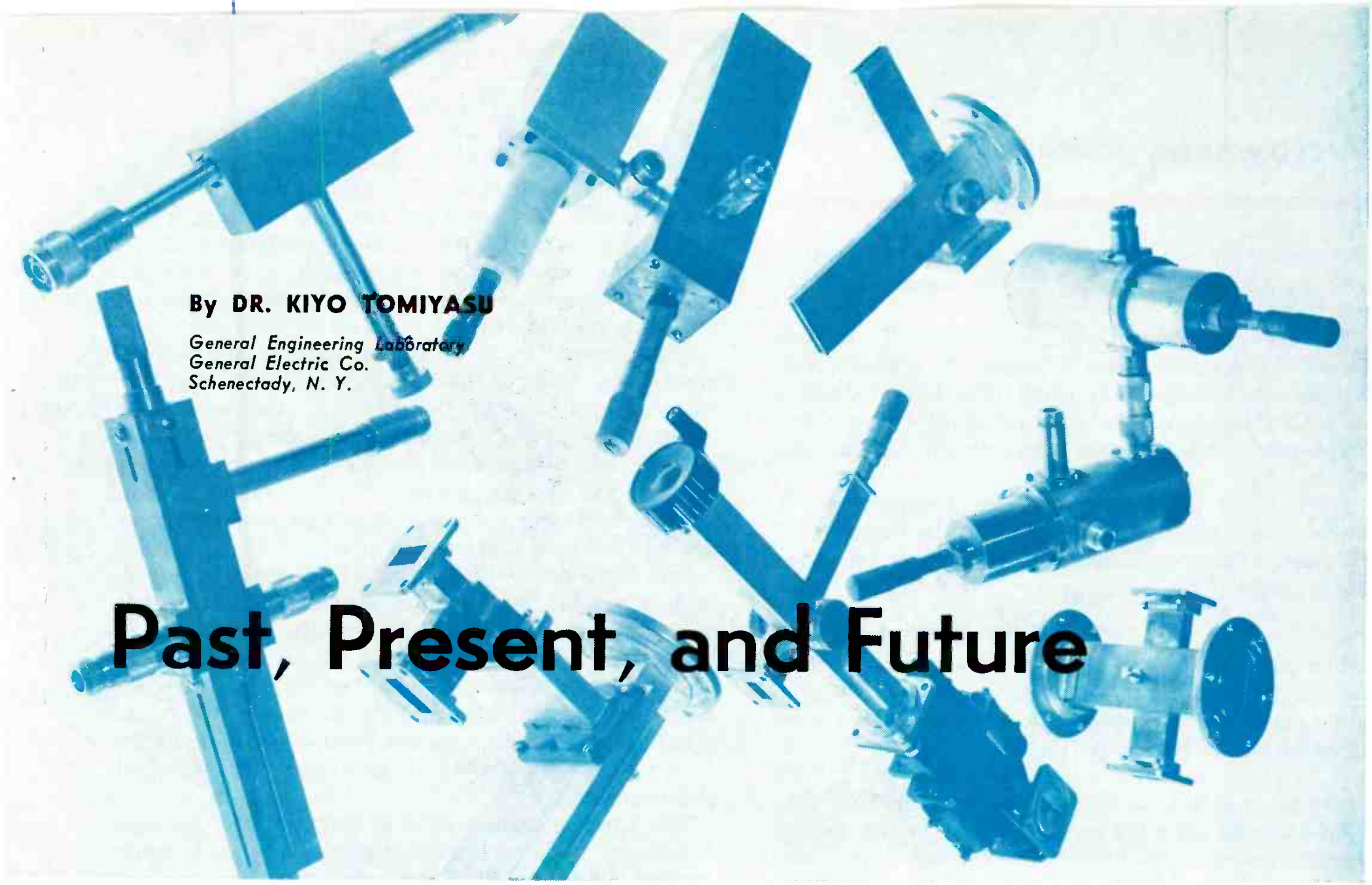
At the extremely high frequency end of the spectrum—infrared and visible radiation—circuit elements have dimensions which are often many thousands of wavelengths. The tangible entities are quantities such as focal length, aperture, polarization, etc.

Between these limits, circuit elements may have dimensions comparable to wavelength. This is the portion which is broadly referred to as the microwave band. The band may cover from 100 MC to 100 KMC with greater engineering importance between 1 and 35 KMC.

At microwave frequencies, the low-frequency lumped constant elements are replaced by distributed constants. And, many optical principles can be applied directly. Microwave power can be transmitted inside a single hollow conductor or waveguide, unlike the two conductors necessary at low frequencies. Like light, microwaves can be confined and transmitted by a straight waveguide; but unlike light, microwave power flow direction can be changed, easily, by the waveguide—without loss in power.

In microwave circuits, voltages and currents are no longer unique; and, these quantities are often re-

DR. TOMIYASU is a member of the IRE-PGMTT Administrative Committee and served as Chairman of that group during 1960-61. Prior to his election as Chairman, he was Editor of the IRE Transactions on MTT. He is currently on the IRE Editorial Board.



By DR. KIYO TOMIYASU

General Engineering Laboratory
General Electric Co.
Schenectady, N. Y.

Past, Present, and Future

placed by electric and magnetic fields. Impedances no longer have unambiguous definitions and their calculations often involve stored energies in evanescent modes.

The earliest work at microwave frequencies used incoherent sources, such as spark gaps and radiant lamps. It was fairly clear that many important uses had to await the development of a more powerful coherent source. Such a source was invented by Varian in 1938. This later became the klystron. With the new tube, a new era of engineering developments followed, leading to the success of radar and numerous other achievements.

Microwave is popularly discussed in terms of its more dramatic use—radar. The importance of microwaves is actually much broader than for radar alone. The theory and techniques, being so vastly different from either radio frequency or optics, have found powerful applications in many diverse fields of science and engineering. The extent of the application is gradually widening, the rate being limited primarily by the speed of cross communication between unique technical disciplines.

As many scientific and engineering technologies have demonstrated explosive growth during the past 10 to 15 years, microwave has been no exception. During this period, many new technical developments have emerged, such as microwave spectroscopy, microwave communication, ferrites, microwave maser, parametric amplifier, microwave plasma diagnostics, high power microwaves, optical maser, etc. The present era of technological revolution can be attributed to many factors, among which are recognition of scientific importance to social advancement, exploitation of latent technical capabilities, rapid and relative ease in technical communication through journals and conventions.

What is the future of microwaves?—especially after so many advances have been made! Instead of making debatable general predictions, let's discuss a few specific areas and highlight some of the barrier problems and trends towards further development.

Ferrite

Following the unbelievable 1952 achievement of non-reciprocal behavior in a microwave solid state device using ferrite, the use and production of ferrite components appeared very quickly—within 1½ years. Until then unattainable performance such as circuit isolation and non-reciprocal phase shifters uncovered other developments and stimulated further device study. Some recent components are ferrite power limiter, ferrite amplifier, isomodulator, etc. In less than a decade, ferrites have attained product maturity; the forecast is steady growth. New materials are being studied which should optimize present components and possibly suggest new ones.

Varactor Diode

Perhaps one of the most simple, intriguing and versatile circuit elements is the semiconductor diode. In an ideal lossless form, it becomes a variable capacitance or varactor. The breadth of circuits and uses appear virtually limitless and analytical papers published match this breadth.

Although parametric circuit principles have been known for many decades, recent developments make frequent reference to the Manley-Rowe relations published in 1956. Perhaps the characteristic that gave the parametric circuit a surge of interest is its capability of amplifying weak microwave signals with virtually no added noise. The critical need for simple low-noise microwave receivers, required for space communication and improved ground communication systems, appears to be met by the solid-state parametric amplifier.

Further improvements will rest primarily on improved varactors in terms of higher Q, higher cutoff frequencies, higher power along with low production costs. Certain uses suggest multiplicity of elements and an eventual form of a continuous distributed configuration.

While many present applications of varactors will continue into the foreseeable future, the overall field will likely expand considerably—limited only by device improvements.

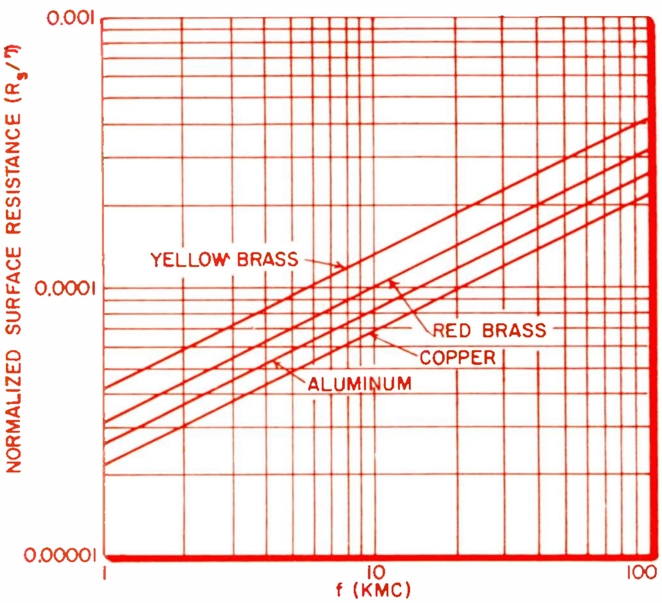
High Power Microwave

The term, high power, is a relative quantity. Most present-day microwave applications can use higher power, and, if higher powers can be generated, new applications can be found.

It is clear that the technological limits of high power generation have not yet been reached. The capabilities can be extended to higher peak power, higher average power, and higher frequencies. The most serious problems facing the tube designer are efficiency, beams, thermal problems, long life, output windows and spurious-free outputs. Other problems may be bandwidth, linearity, amplitude and phase stability.

After the successful development of a super power tube, tube applications will depend heavily on the mutual compatibility and design dependence of source, components, techniques and system. In advance testing of components and technique development, profitable use is often made of resonant cavities and traveling-wave resonators to simulate the anticipated peak powers. Some caution is required since the source impedance cannot be simultaneously simulated.

Fig. 2: Surface resistance normalized to free-space impedance (377 ohms) as a function of frequency for four common materials.



In the design of super power components, even minute insertion losses in db become significant in terms of watts. New approaches are required which can be readily fabricated and meet the eventual operational environment. Any components oversized in dimensions compared to wavelength must consider mode conversion problems to be encountered under the operating conditions.

Super power levels raise the natural question of breakdown. What is the highest power level that any component can carry? Breakdown in vacuum cannot be reliably predicted. At above-atmospheric pressures, the effects of non-uniform electric fields have not been fully studied. In the presence of appreciable amounts of spurious frequency power, the breakdown phenomenon has not been investigated at all.

One component which often arcs or "sizzles" under high power is the waveguide coupling flange. Spurious and harmonic frequencies probably contribute to the sizzling. Although the problem carries much engineering significance, it does not seem to have received sufficient attention. Perhaps this is due to its relatively mundane nature and because no single flange design can meet most packaging and environmental requirements.

The wireless transmission of megawatts of average microwave power over distances of ten miles is being studied by Raytheon for a space platform application. Fairly efficient generation and radiation of the microwave power has been designed, and energy conversion at the receiver involves a thermal cycle. Power converters which will convert microwaves into dc are now being studied by Raytheon and Purdue University. Very efficient converters especially at the highest power levels are still needed. A device which can convert microwaves into mechanical power, i.e., a microwave motor, should find many applications.

During the past few years, solid-state devices such as transistors and junction diodes have replaced some of the low power thermionic tubes. It does not appear that solid-state devices are an obvious threat to replace high power tubes. However, recent pulsed ferrite experiments offer some bases for speculation.

Phase Shifter

Among microwave components, that which often forces the microwave designer to an uncomfortable position of compromise, is the electronically-controllable phase shifter. Some of the desired specifications are: (1) accuracy, (2) phase range, (3) fast response, (4) small drive power, (5) high microwave power, (6) light weight, (7) small volume, (8) small insertion loss, (9) bandwidth, etc. Ferrites and junction diodes have been used in phase shifters but there is much room for improvement, especially at high microwave power levels.

Although not continuously variable, a discharge in the form of a switch can be used in a digital-type phase shifter. The discharge switch can be externally controlled but the microwave power levels must be relatively small, lest the microwaves will control the discharge. Among discharge type switches, the multipactor is the only one which can be either initiated or quenched while the high level is applied. In addition to this feature, the switch has fast response time and requires small drive power; hence it should be beneficial for digital phase shifting of high power microwaves.

Microwave Maser

With the impetus on microwave technology during the early 1940's, and with the predicted and verified K-Band absorption due to water vapor, a new field of microwave spectroscopy was launched. Much of this early work on extremely high resolution spectroscopy was carried out by Professor C. H. Townes, Columbia University. These studies contributed immensely to the knowledge on structure of matter. From this work arose the development of the K-Band maser, which is a microwave amplifier using a beam of ammonia molecules instead of a beam of electrons. The maser provided unprecedented low noise figures, bordering the ideal. Subsequent developments led to solid-state masers using ruby, rutile and emerald. These devices are tunable using a magnetic field.

Though initially handicapped by narrow bandwidth, recent solid-state traveling wave structures provide practical bandwidths. The low temperatures required will prevent universal application but the microwave maser is irreplaceable in specific applications such as primary frequency standards, radio astronomy receivers, etc.

Optical and Infrared Maser

One of the most startling achievements in modern physical science is the generation of coherent light. A coherent signal is defined as one which is monochromatic, unipolarized and uniphased across an aperture. In rapid succession three materials were announced, viz, ruby, impurity-doped calcium fluoride, and helium-neon gas mixture, which generate coherent waves at red and infrared wavelengths. The principles of these masers were published by Townes and Schawlow in 1958 and the first optical maser was announced in 1960 by Hughes Research Laboratory.

One of the predicted uses of the optical maser is wideband communication where, in theory, a 1% bandwidth can handle simultaneously one million television channels! The realization of this capability will however require very extraordinary advances in modulation and demodulation techniques. Other factors to be considered are signal-to-noise ratio, channel capacity, inter-channel interference and terminal equipment.

Due to the combination of high output power and narrow emission linewidth (narrow radiation beam) it should be possible to communicate over astronomical distances through space. The narrow radiation beam should make it possible to search the moon with a ten-mile diameter beam using an optical maser transmitter on earth.

Inasmuch as the emitted linewidth is so narrow, the energy can be focused into a spot size comparable to a wavelength. By focusing the high power output from a ruby optical maser, small holes have been drill-in razor blades. Under strong focused fields, quartz exhibits non-linear behavior, and a second-harmonic blue light has been generated by extremely intense red light emitted from a ruby optical maser.

The only maser using gas delivering continuous power in the infrared region is the one which uses a mixture of helium and neon announced by Bell Telephone Labs in January 1961. The infrared emission linewidth is significantly less than that from the ruby and it should be possible to make interferometric measurements over distances of 18 miles!

The present vigorous search for new maser materials will likely continue for many years. Without doubt there are countless applications of optical masers and practical uses will be found for all devices regardless of the emitted wavelength and whether pulsed or continuous output. Perhaps it is significant to note that maser technology has jumped from microwave to optical wavelengths. The microwave-infrared gap is still relatively undeveloped and until more powerful sources and more sensitive detectors become available, advancements in this gap will be meagre.

Despite the current explosive activity on, and study of, optical masers, there are many technical areas which demand scientific and engineering attention. These are elimination of relaxation oscillations, high overall efficiency, wide range in power output, wide range in emission wavelengths, continuous output, high peak power, etc.

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The early optical and infrared masers are self-excited oscillators. Although oscillators are regenerative amplifiers, it was not obvious that a coherent amplifier could be built. However, such an amplifier using ruby was successfully built by Bell Telephone Labs during the spring of 1961. Power gains of two were obtained. Further areas of development would be to achieve higher power gain, lower signal sensitivity, higher S/N ratio and tunability.

The optical maser and its applications are in a stage of infancy. While the technical problems are numerous, there is general agreement that the expected rewards justify the effort.

Other Devices and Applications

As a diagnostic tool, microwave signals have been used to probe high density plasmas. High power at millimeter wavelengths is required to probe extremely dense plasmas. NASA is speculating that interaction of plasmas may generate extremely high power microwaves useful for space communication.

Microwave phonons which can freely propagate in quartz at cryogenic temperatures have been useful in studying the structure of matter. Intense microwave phonons have been demonstrated to amplify parametrically microwave signals through induced non-linearity in quartz.

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Designed for use in final radar system tests, this space type load presents a constant magnitude, variable phase, reflection to the transmitter. It is useful in studying the effects of transmitter-to-antenna mismatch caused by abnormal weather, such as icing conditions.

Radar Antenna Test Load

By THOMAS J. RUSSELL
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DETERMINING the effect that abnormal operating conditions have upon a radar is an important part of a radar testing program. Transmitter-to-antenna mismatch is one undesirable situation that abnormal weather—such as icing conditions—can cause. Severe transmitter to antenna mismatch may shift the transmitter frequency enough to cause the radar to malfunction. It is probable that a shift in the transmitter frequency due to mismatch is a function of both the magnitude and phase of the reflected wave.

Here we discuss a space type load that presents a constant magnitude, variable phase, reflection to the transmitter. This antenna load is to be used in a final radar system test. An output not more than 25 db down from the antenna input is to be incorporated in this antenna load. This output will be used with a transponder to provide the antenna with an echo signal.

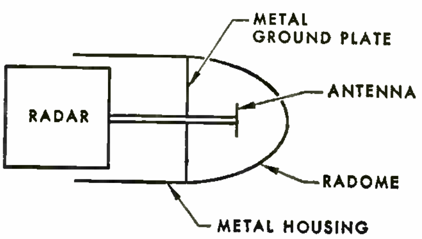

Fig. 1: The radar antenna under test was located in a radome.

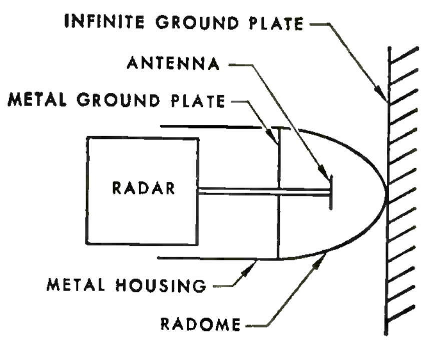

Fig. 2: A maximum vswr of 1.4 was introduced when the radome was placed against an infinite ground plane.

This antenna load was required to provide a constant magnitude, variable phase, reflection coefficient at the antenna input terminals. The reflection coefficient is to be continuously variable through 360°. This 360° reflection coefficient phase variation causes the antenna input impedance to traverse a constant VSWR circle on a Smith transmission line chart. It was assumed, for this work, that 1.7 would probably be the maximum VSWR caused by severe weather conditions. Thus, the required load would cause the antenna input impedance to traverse a 1.7 VSWR circle on a Smith transmission line chart.

The antenna for this radar is located in a radome as shown in Fig. 1. The antenna provides a vertically polarized broad beam radiation pattern that is symmetrical about the radome axis. Over the operating frequency band the antenna and transmitter are matched to the 50 ohm line connecting them. The operating frequency bandwidth is about 4% of the center frequency.

It was found that a rather severe discontinuity in

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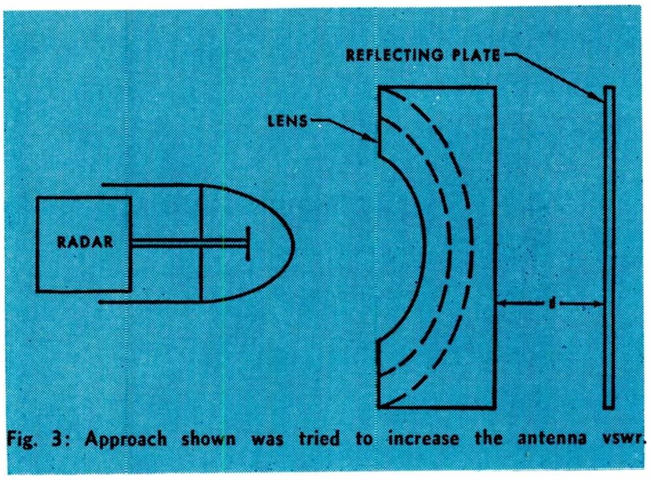


Fig. 3: Approach shown was tried to increase the antenna vswr.

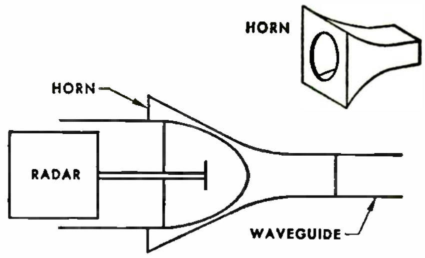


Fig. 4: To increase antenna vswr an antenna-to-rectangular-waveguide match was tried.

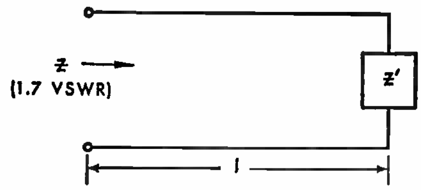


Fig. 5: Illustrated is a variable length of waveguide terminated in an impedance that presents a 1.7 vswr.

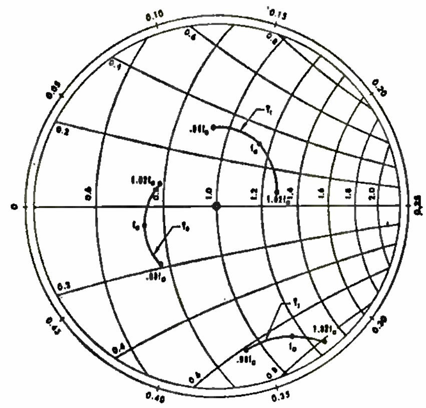


Fig. 6a: The horn output admittance curve, Y₀ is shown plotted on a Smith chart.

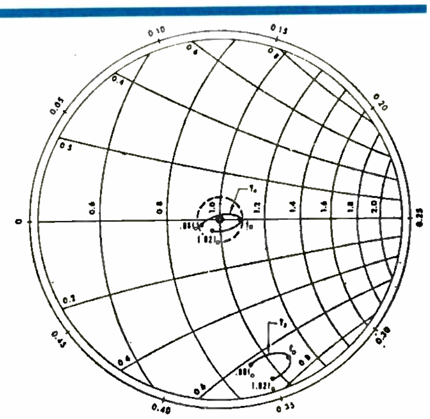


Fig. 6b: This curve and the one above show how the matching network transforms the horn output admittance into the 1.1 vswr circle.

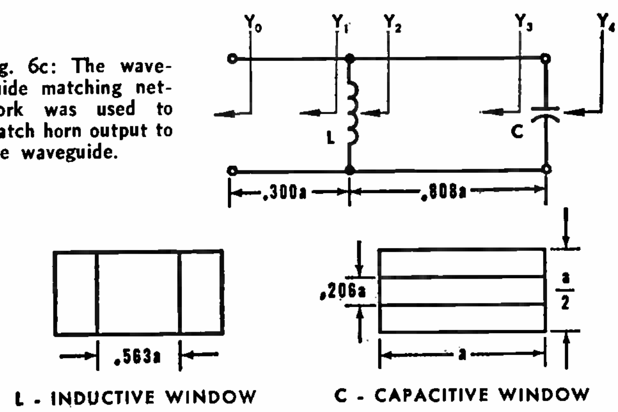


Fig. 6c: The waveguide matching network was used to match horn output to the waveguide.

the space surrounding the radome was necessary to produce a 1.7 VSWR in the antenna input line. This is illustrated by the fact that 1.4 was the maximum VSWR introduced when the radome was placed against an infinite ground plane as shown in Fig. 2.

One approach to the problem used a parallel plate metal lens as shown in Fig. 3. The theory was to collect the antenna energy and transform it into a plane wave with the lens. The phase of the reflected wave could then be adjusted by varying the distance d to a metal reflecting plate. This system was unsuccessful due to wide VSWR variations with changes in d. This was probably largely due to antenna to lens mismatch.

A common difficulty encountered in several approaches tried was the collection and reflection of enough energy to give a 1.7 VSWR. It was decided to collect all of the antenna energy and attempt an antenna-to-rectangular-waveguide match as shown in Fig. 4. The vertically polarized field produced by the antenna is compatible with the generation of a TE_{10} mode in the waveguide. The mouth of the horn was covered with a metal plate with a hole in the center fitted to the metal housing. The transition from antenna input to horn output could then be considered a lossless two-terminal pair network. If the antenna were matched to the waveguide and a waveguide load Z transversed a constant VSWR circle on a Smith transmission line chart, the antenna impedance would traverse the same constant VSWR circle. The system shown in Fig. 5 would provide the required Z. The antenna input VSWR varied between 1.3 and 1.4 over the frequency band with the waveguide in Fig. 4 terminated in Z_o.

Let ρ equal the input VSWR with the waveguide in Fig. 4 terminated in Z_o. It has been shown that the antenna input VSWR, with the waveguide terminated in Z of Fig. 5, will vary between 1.7ρ and $1.7/\rho$ as l is varied through ½ wavelength.[1] A ρ of 1.1 would allow the input VSWR to vary between 1.54 and 1.87. Thus, to maintain a reasonably constant input VSWR, it was necessary to match the antenna to the Z_o terminated waveguide within a 1.1 VSWR over the frequency band. The problem was then reduced to designing a matching network to match the horn output impedance to the waveguide.

1. G. L. Ragan, "Microwave Transmission Circuits," Vol. 9, *M.I.T. Radiation Laboratory Series*, 1948, p. 553.

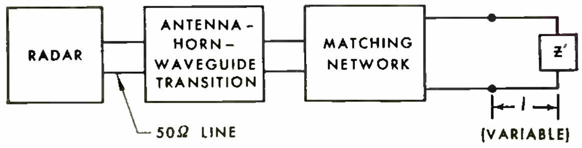


Fig. 7: Block diagram shows the antenna load system used.

Test Load *(Concluded)*

The output admittance of the horn can be found by the following procedure.[2]

1. Record the standing-wave ratio S and position of the minimum in the input line with the horn output terminated in Z_o.
2. Determine the distance in guide wavelengths from the horn output to a short in the waveguide such that the corresponding minimum in the input line coincides with that in measurement 1.
3. Enter a Smith transmission line chart at $1/S$ and travel counter-clockwise on a constant VSWR circle the number of wavelengths determined in 2.
4. The point reached in 3 is the output admittance of the horn normalized with respect to Z_o.

The horn output admittance curve, Y_o, is shown in Fig. 6a.

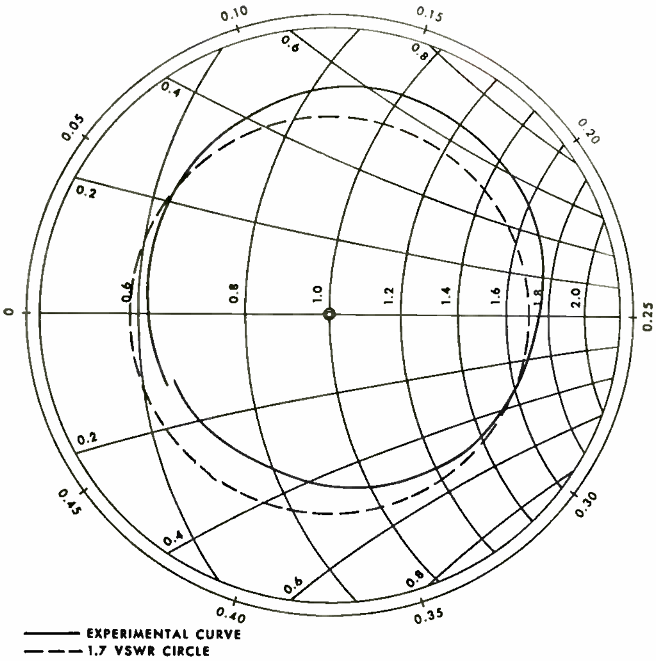
The waveguide matching network shown in Fig. 6 was used to match the horn output to the waveguide. The curves in Fig. 6 show the manner in which the matching network transforms the horn output admittance into the 1.1 VSWR circle.

The complete antenna load system is shown in Fig. 7. The insertion of a small output probe in the waveguide presented no difficulties. Fig. 8 shows the antenna input impedance curve obtained at f_o as l was varied through ½ wavelength.

The author wishes to thank Mr. Lyle A. Robinson for his many valuable suggestions.

2. N. Marcuvitz, "Waveguide Handbook," Vol. 10, *M.I.T. Radiation Laboratory Series,* 1951, p. 132.

Fig. 8: Antenna input impedance curve provided by the system.



By C. LOUIS CUCCIA

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Modern

THE earliest traveling-wave tubes used magnetic focusing fields provided by heavy, cumbersome solenoids. Solenoids are still widely used with certain types of traveling-wave tubes, such as very-low-noise tubes, tubes requiring very strong magnetic fields, or tubes designed to deliver power outputs in the tens-of-kilowatts or megawatt range.

During the 1950's, however, under the impetus of the growth of electronic radar countermeasures and other airborne systems, intensive study of different focus structures resulted in the development of small, light-weight integrally packaged tubes containing the focus structure within the tube capsule.

Integrally packaged TWTs now employ at least three modern focus techniques: uniform-magnetic-field focusing provided by miniaturized solenoids or permanent magnets, electrostatic focusing, or periodic-permanent-magnet focusing. This article describes the features of each type of structure.

Frequency Coverage & Power

Integrally packaged TWTs have been developed to amplify over wide frequency bands from the 500 to 1000 MC octave to the 12,000 to 18,000 MC band, and to provide saturated power outputs ranging from milliwatts to more than ten kilowatts. Such tubes, in general, weigh from 2 to 6 lbs. for low-power and low-noise types up to 15 to 20 lbs. for the highest-power tubes—a far cry from the early solenoid-focused units which weighed several hundred pounds and consumed kilowatts of solenoid power.

REFERENCE PAGES
The pages in this section are perforated for easy removal and retention as valuable reference material.
SOMETHING NEW HAS BEEN ADDED
An extra-wide margin is now provided to permit them to be punched with a standard three-hole-punch without obliterating any of the text. They can be filed in standard three-hole notebooks or folders.

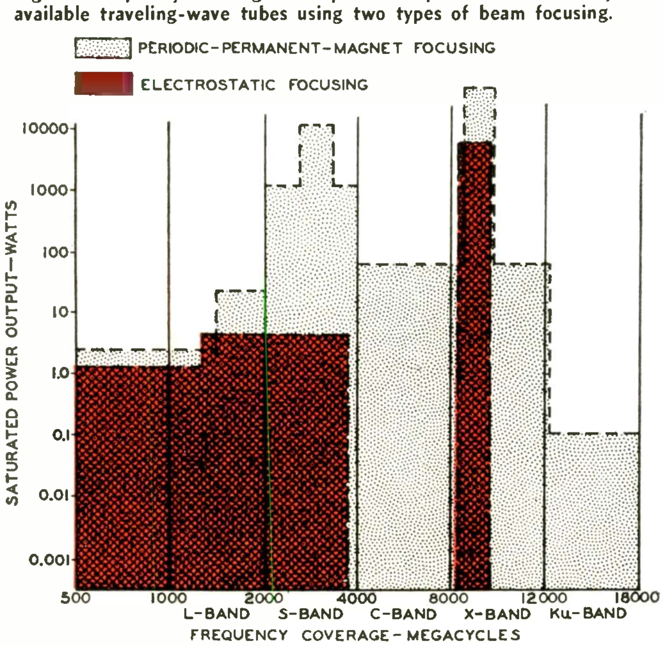
The heart of many microwave systems is the traveling-wave tube. Integrally packaged TWT's used today employ three focusing techniques. The features of each are presented here, in a concise manner, as an aid to proper selection.

TWT Focusing Methods

Fig. 1 relates frequencies from 500 to 18,000 MC to the highest power-output levels obtainable from both periodic-magnetic and electrostatically focused TWTs developed by the microwave industry in the last few years, with the major activity directed toward periodic magnetic focusing. In the very active radar-frequency ranges in mid S-band and lower X-band, tubes having saturated power outputs up to the ten-kilowatt level have been developed. At lower powers (i.e., 1 watt and less), a wide variety of very-wide-band tubes have been developed to cover all the frequency bands indicated. Integrally packaged uniform-field tubes (not shown) are used primarily for very-high-power and low-noise applications.

Fig. 2 compares the appearance of integrally packaged TWTs using the three modern focus structures

Fig. 1: Frequency coverage and power output of commercially available traveling-wave tubes using two types of beam focusing.



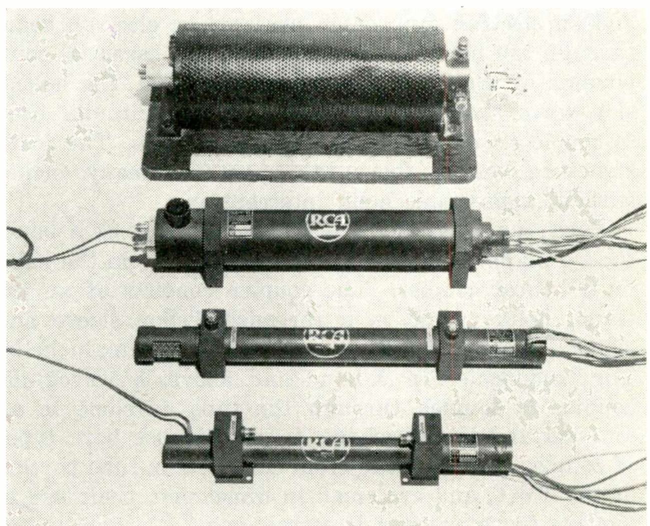
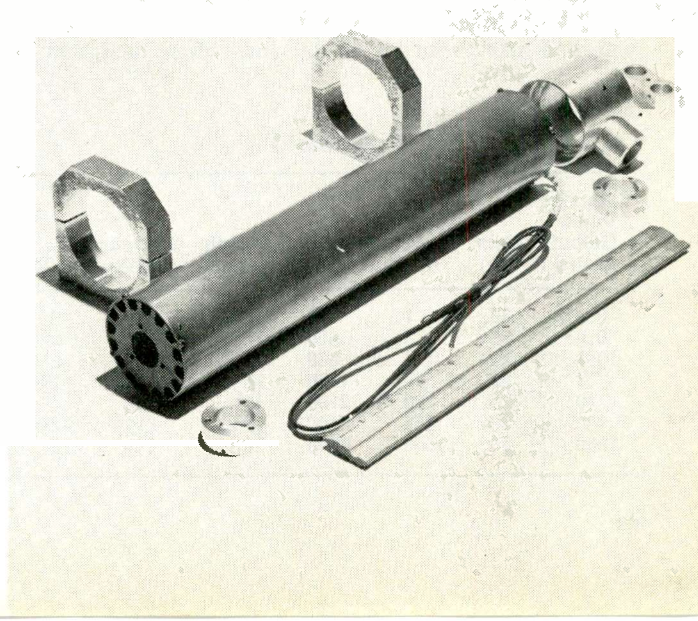


Fig. 2: Comparison of TWT's with various focusing methods.

Fig. 3: A miniature TWT solenoid making use of aluminum foil.



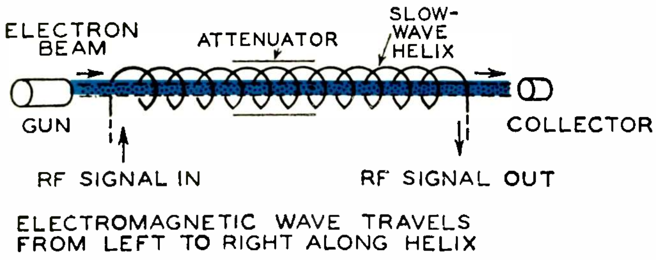


Fig. 4: The basic structure of a traveling-wave tube is shown.

TWT Focusing *(Continued)*

with that of the 6861 low-noise tube and its 40-lb. solenoid. The photograph shows the large reduction in size resulting from the modernization of the focus structure.

Basic TWT Structures

The basic structure of a TWT is shown in Fig. 4. The tube contains a slow-wave structure, such as a helix, along which the wave to be amplified travels, and an electron gun which projects an electron beam through the helix to the collector. The essential components of the TWT are the electron gun, the helical slow-wave structure, the collector, the circuits used to couple r-f energy to and from the helix. The focus structure has to focus the beam for many inches without appreciable helix interception.

For frequencies in L-, S-, C-, and portions of X-band, the r-f signal is applied to or extracted from the helix by a helical coupler. The coupler consists of an external helix wound in a threaded Teflon sleeve and coupled through the tube envelope to the main helix. For frequencies in X-band and above, a waveguide coupler is coupled through the tube envelope to an antenna at one end of the helix. Because both types of couplers are separate from the electron-tube portion of the TWT, and are small in dimension, their use in modern focus systems is attractive.

Uniform-Field Focusing

The solenoids and permanent magnets used for focusing TWTs have normally consisted of large heavy structures. A wire-wound solenoid, even of modern design (typified by the solenoid shown in Fig. 2), weighed in the order of 40 lbs. when designed for use with S-band tubes. Permanent-magnet focus structures of the "football" type, designed for similar tubes, weighed considerably more.

The advent of aluminum-foil types of solenoid has made possible miniaturized uniform-field focus structures of substantially reduced weight and size. Fig. 3 is a photograph of an aluminum-foil solenoid structure illustrating these features. This structure weighs 6 lbs., is 2½ inches in diameter and 13½ inches long, and has a focus region 0.850 inch in diameter. Such solenoids have been successfully used for L- and S-band low-noise tubes.[1] They are small enough to permit integral packaging of the focus structure and electron tube, as illustrated.

At C- and X-band, the reduced size of the electron-tube structure permits the use of miniaturized "football"-type permanent magnets weighing less than 15 lbs. X-band integrally packaged low-noise tubes have been developed[2] with package weights comparable to that of the miniature-solenoid-focused tube of Fig. 3.

Table 1

Saturated Power Output (watts)	Gain (db)	Beam Current (ma)	Helix Volts	Length (inches)	Diameter (inches)	Weight (lb)
0.015	35	1	475	15⅞	1 1/16	3
0.01	35	3	600	15 3/16	1 1/16	2¾
0.1	35	4	600	14 3/16	1 1/16	2¼
1	33	19	1100	15 3/16	1 1/16	2¾
10	25	60	2100	18½	1½	4
100	30	250	3700	19⅝	2½	12½
1000	30	1500	7800	21	2½	15

Fig. 5a: Cross-sectional view of bifilar-helix type structure.

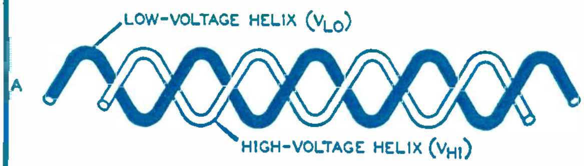


Fig. 5b: Forces exerted on an electron in focus structure.

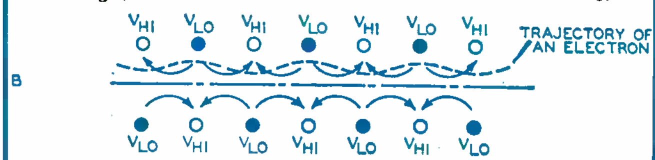
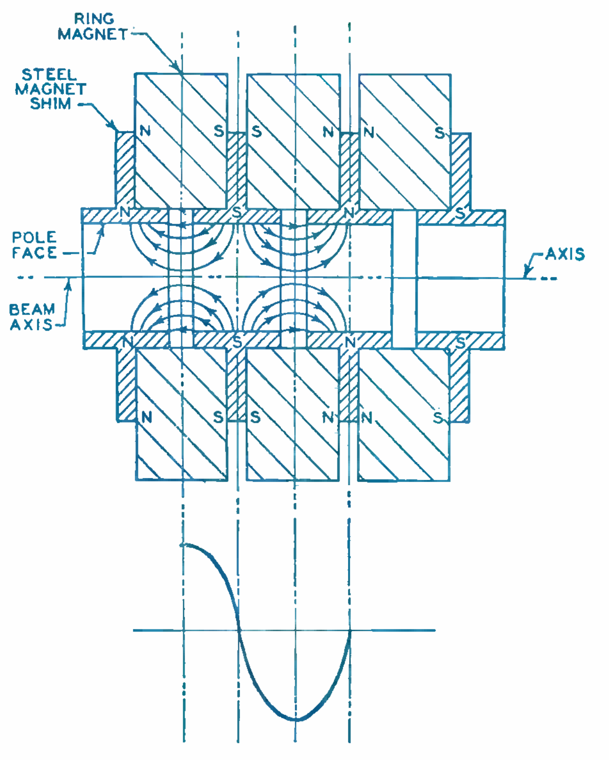


Fig. 5c: Cross-sectional of periodic permanent-magnet focusing.



Periodic Focusing

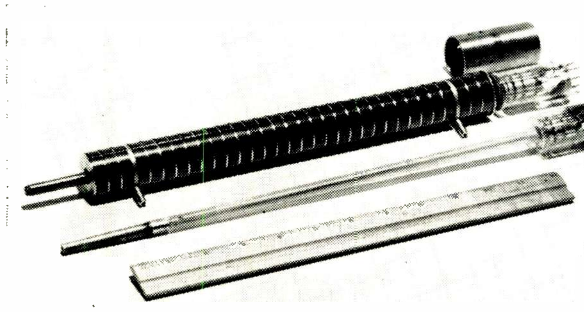
A TWT can be periodically focused by means of the bifilar-helix structure[3-5] shown in Fig. 5a. This structure consists of a pair of interleaved helices having the same diameter and turns-per-inch ratio. When the two helices are operated at different potentials, they produce the same effect as a series of closely spaced lenses. The electrostatic focusing action is therefore periodic, being repeated at very small intervals and used to balance the outward radial force on the electrons. The forces exerted on an electron and the resulting electron trajectory are shown in Fig. 5b. The bifilar helix not only provides focusing action, but has the same wideband characteristics and the same ability to couple to helical couplers as a single-helix slow-wave structure. Consequently, its use in a TWT results in no degradation of performance.

The technique of focusing the electron beam in TWTs by means of periodically spaced, permanent ring magnets[6-9] has gained the widest acceptance of all focusing methods to date. Such periodic-focus structures are easily miniaturized, operate over wide ranges of ambient temperature, require no focusing power, and produce negligible stray magnetic fields and helix interception.

Fig. 5c shows a portion of a structure of ring magnets and steel shims designed to produce a periodic magnetic field. Each ring magnet is magnetized so that north and south poles are produced on its side faces. The ring magnets are then stacked between steel shims with the similarly polarized faces of each pair adjacent. The facing south poles of adjacent ring magnets produce a south pole in the steel shim between them, and the facing north poles of adjacent ring magnets produce a north pole in their common steel shim. The strength of the magnetic field along the axis of the structure thus varies periodically, being zero in a plane through the center of each steel shim, and maximum in a plane through the center of each ring magnet.

An electron beam passing along the beam axis, and provided with sufficient accelerating voltage, is constrained most in regions where the force exerted by the magnetic field is at a peak positive or negative value, and constrained least in regions where the magnetic field passes through zero.

Fig. 6: Tube is designed for use with a periodic permanent-magnet focus structure and for electrostatic focusing.



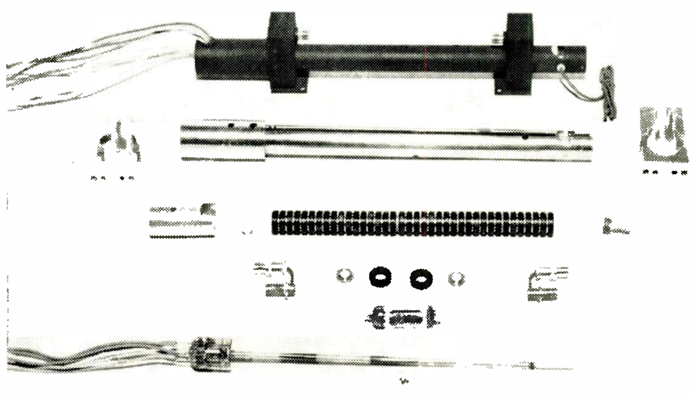


Fig. 7: Final package and the principal TWT components.

Fig. 6 is a photograph of 10-watt S-band TWTs designed for use with a periodic-permanent-magnet focus structure (which is included in the photograph) and for electrostatic focusing by use of a bifilar helix (which is inside the tube envelope). The feature of minimum bulk is evident from these structures.

Fig. 7 is a photograph of the final package and the principal tube components of a TWT. It illustrates the structures generally representative of the components of the tubes using periodic-permanent-magnetic focus structures.

Table 1, which lists the pertinent electrical and mechanical characteristics of selected S-band TWTs, illustrates the wide range of beam currents and helix voltages representative of tubes having saturated power outputs from 10 mw to 1 kw, and operating in the frequency range from 2000 to 4000 MC.

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The recent experiments at Frankford Arsenal have shown that high power RF testing of microwave components is necessary to ensure that performance is accurately assessed.

High Power Microwave Component Testing

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THE merits of high- versus low-power RF testing have been argued pro and con for a long time. In order to eliminate the necessity for high power RF testing, many attempts have been made to correlate both these techniques; unfortunately, few high power test facilities have been available to conclusively resolve this question.

Recently, however, due to the construction of a new high-power test facility at Frankford Arsenal, it has been possible to conduct positive comparison tests on components such as waveguide rotary joints and waveguide sections by using both low and high power test facilities. These components checked out well on the low power VSWR test equipment. Then, to simulate a minor environmental change, a few grains of fine sand were blown into the rotary joint, which was again tested on the VSWR test set-up with no resulting change. However, when the rotary joint was tested with the high power test set, arcing occurred at half power. The rotary joint was immediately retested on low power and again no change was found from the original condition. Similar results were obtained on a wave-guide section containing a slight deformation on the wall of the guide. Thus it can be seen that, in this situation at least, low power test results cannot be extrapolated to high power conditions.

Dummy Loads

A particular waveguide component which, in the past, has seldom been adequately tested under high power conditions is the waveguide dummy load.[1] A dummy load is designed to simulate the lumped characteristics of an electrical circuit and to dissipate energy in the form of heat for measurements or maintaining RF silence. The load must perform its function within the following limitations:[2]

(1) Minimum voltage standing wave ratio.
(2) Minimum heat reflections from load into associated equipment.
(3) No electrical or mechanical breakdown of load.
(4) No arcing within load or system.
(5) No breakdown in system from gases and water emitted from load.

It is known that the power distribution within a load will vary with frequency, design configuration and material used. A well-designed load will have maximum power dissipation near the mounting flange, but sufficiently distributed to keep heat reflection from the load to the system at a minimum. It is also recognized that heat transfer is a function of the absorbing, bonding and outer shell materials as well as the physical configuration. Where a bonding material is not used, heat transfer will vary directly with the surface area contact of the absorbing and outer shell materials.

Temperature Effects

Referring to Fig. 1, the temperature t_1 at a given point on the inner surface of the load will be a func-

*Formerly Program Manager Frankford Arsenal tion of the frequency and power output (input to the load) of the system under test, in addition to the internal configuration of the load. For good design of a load the temperature differential $t_1 - T$ should be minimized. The temperature differentials are given by

$$\Delta t_n = \frac{P_i W}{KA} \quad (n=1,2,3)$$

where P = power dissipated; W = wall thickness; A = inner surface area, and K = thermal conductivity of dissipative material. The ratio P/A is the power dissipated per unit of inner surface area.

The outer shell surface temperature T will be a function of the ambient temperature and of the heat transfer:

$$T = t_{\text{ambient}} + \Sigma \Delta t_n$$

It should be recognized that a rise in t_1 will not only increase the temperature of the dissipative materials but will also increase the temperature of the atmosphere within the load. The amount that t_1 increases will be determined from the inability of the dissipating material to remove the heat from the inner surface of the load. If the dissipating material has a high thermal barrier, heat will be forced by conduction, convection, and radiation inward to the atmosphere in the load. This will cause air circulation within the waveguide system, thereby increasing the inner atmospheric temperature and creating the possibility of system breakdown. Moisture or water in the load prior to the application of power will vaporize. The air circulation will transform the vapor back again to moisture elsewhere in the system where it can cause breakdown or arcing.

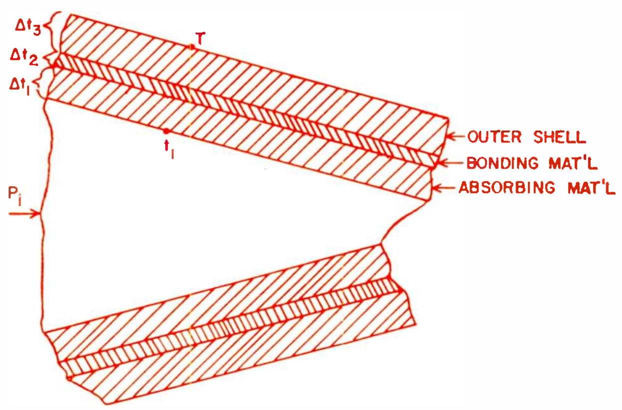

Fig. 1: Temperature Distribution in a Dummy Load.

Materials and Moisture Control

Concerning the inner materials, good load design requires that the following be considered.

a. High moisture absorptive materials (e.g., wood without impregnant or sealer) will retain a large amount of moisture under humidity or actual soaking conditions. Sudden application of high power from a system would have a tendency to drive this moisture out of the load so rapidly as to create an explosion. This was vividly demonstrated when such an explosion occurred in the test program for the preparation of Specification MIL-D-14454(ORD) Dummy Load, Electrical. Excessive moisture in the load will cause arcing, breakdown and a change in the VSWR.

b. When an improper impregnant is used, testing has shown that repeated power cycling will change the physical and electrical characteristics of the impregnant, resulting in the same failures as indicated for materials without impregnants.

c. Dissipating materials themselves may undergo physical or electrical changes as a result of power cycling. Where an improper plastic absorptive material or an incompletely cured absorptive material is used, power cycling may thermally stress this material, resulting in mechanical and electrical failure of the load and system. Further, the material thermal conductivity may also be affected by a change in its bonding chemical during power cycling. Some materials also have elastic properties which result in a change of VSWR and thermal conductivity as a function of the applied power.

The area between the inner and outer shells may be filled with a bonding material or may be dependent on direct surface contact for heat transfer. A temperature differential will result in either a temporary or permanent separation in the area, thereby reducing K and increasing Δt_2. Where a bonding material is used, temperature changes may result in its physical breakdown, causing deterioration of the material and contamination of the system. Arcing or breakdown results, as demonstrated with the sand particles.

Power Cycling

Power cycling in a closed system will cause a temporary or permanent deformation of the outer shell material due to the combined effects of temperature and pressure. Deformation could cause bonding separation between the inner and outer shells, thus increasing Δt_3; pressure leaks could develop resulting in system arcing and breakdown.

The limiting factors in RF breakdown in a system using a dummy load are:[3]

a. Maximum peak power.
b. Pressurization of the load-system.
c. Inner surface condition of the load (surface roughness).
d. Inner surface dimensional stability of the load (temperature coefficient of expansion).
e. Frequency.
f. Pulse width.
g. Pulse repetition rate.
h. Electrical field configuration.
i. Impurities within waveguide (dirt, moisture).
j. Internal temperature of system (load air).

Average power limitations of a load are:

a. Physical changes of material through heating (deterioration).
b. Electrical changes of material through heating.
c. Thermal shock.
d. Safety (heat transfer should not be harmful to human and equipment).
e. Damaging differential temperatures.

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Thermal Drift in Microwave Power Meters

Although bolometer type microwave power meters have been around for 15 years, not till recently have compensated devices been designed to overcome their thermal drift sensitivity. Here's how to achieve a realistic design goal of 100 times less detector mount drift than previously available.

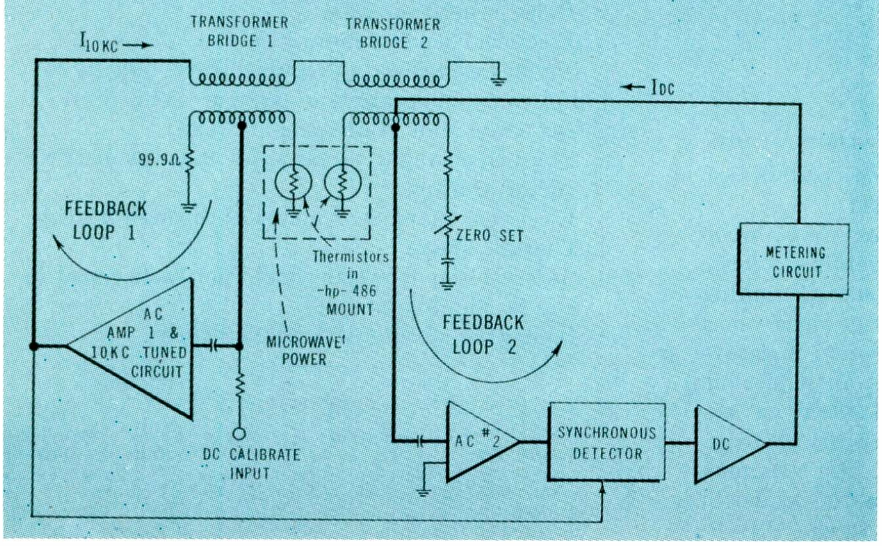
As microwave energy is absorbed by a bolometer element, it is dissipated as heat. The effect of this heat on the element itself is measured and stated in terms of power received. However, ambient temperature also affects the bolometer element; and, this ambient heat effect is erroneously measured along with the microwave power. The extent of this error can be realized by considering what happens when the temperature of a commonly used coaxial thermistor mount changes 1°C. This is equivalent to a 300 mw change in microwave power. Thus, ambient temperature grossly limits the usefulness of 100 μw ranges found on commonly available devices.

There are two possible approaches to this problem:

1. Isolate the bolometer mount by temperature control.
2. Design a circuit able to cancel out first order temperature effects.

Conventional power meter circuitry could be used for the first alternative. However, temperature control would have to be extremely good — because *only one one-hundredth degree centigrade* change would cause a 3 mw drift! Also, suppose the operating range was 0°C to 55°C. This requires an oven at 60°C and thermistor control at that temperature. This is rather impractical.

Fig. 1: Basic arrangement for high thermal stability, using double bridge and compensated bolometer mounts.



Look at the second alternative. A better solution is to use two bridges containing thermistors tied to a common heat sink and biased by a common power source. The effect is analogous to the common mode rejection of a differential amplifier.

Very basically, such a circuit would consist of two bridges, each containing thermistors. Each bridge would be designed with feedback to maintain balance. Both thermistors would be biased by a common power source (the only source of power in the zeroed condition). Microwave current applied to the first thermistor, in the first bridge, would be communicated to the second bridge, and dc current of equal magnitude would be applied to the thermistor in that bridge. In effect, we would have a 1 to 1 microwave current to dc current converter. The dc current applied to the second thermistor, of course, would be easy to meter and state in terms of microwave power.

Circuit Proposal

For a more detailed description of this circuit see Fig. 1. AC amplifier #1 amplifies the unbalanced signal at the bridge. This amplifier contains a circuit tuned to 10 KC. The output of amplifier #1 is fed back to the primary of bridge transformer #1. This is positive feedback, and forms an oscillator which oscillates at 10 KC. The amplitude is controlled by the characteristics of the thermistor. Steady state is reached when the resistance of the thermistor is just slightly greater than 99.9 Ω resistor in the other arm of the bridge. If amplifier #1 has greater than a 60 db gain, the resistance of the thermistor is less than 1/10 Ω greater than the 99.9 Ω resistor. Note that the primary of bridge transformer #2 is now in series with the primary of bridge transformer #1. This means that ac amplifier #1 is providing the bias

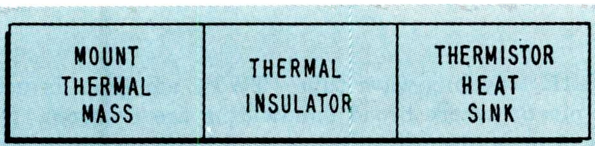


Fig. 2: Thermal technique used to overcome temperature gradients.

for the thermistors in both bridges. The potentiometer in the other arm of bridge #2 is used to trim for any slight variation in the characteristics of the two thermistors, and establish zero.

The unbalanced signal, appearing at the center tap of bridge transformer #2 is amplified, detected by a synchronous detector, dc amplified, and fed back to bridge transformer #2 through the metering circuitry.

Basic Circuit Operation

Now let us trace what happens during operation of this circuit. First, the power meter is zeroed. The only power used to bias the thermistors to 10 kc power, supplied by ac amplifier #1. When microwave power is applied to thermistor #1, it heats it. This starts to unbalance the bridge. To regain a steady state balance, the ac signal, I_{10KC} in Fig. 1, must be reduced. The reduction in 10 KC power applied to this thermistor is equal to the microwave power applied. This reduction in I_{10KC} is also applied to thermistor #2, unbalancing it. This bridge circuit regains balance only when I_{dc} supplies sufficient power to thermistor #2 to bring it back to balance. This is when the dc current supplied to thermistor #2 is equal to the microwave current applied to thermistor #1, since I_{10KC} is common to both through identical transformers.

Thermal Stability

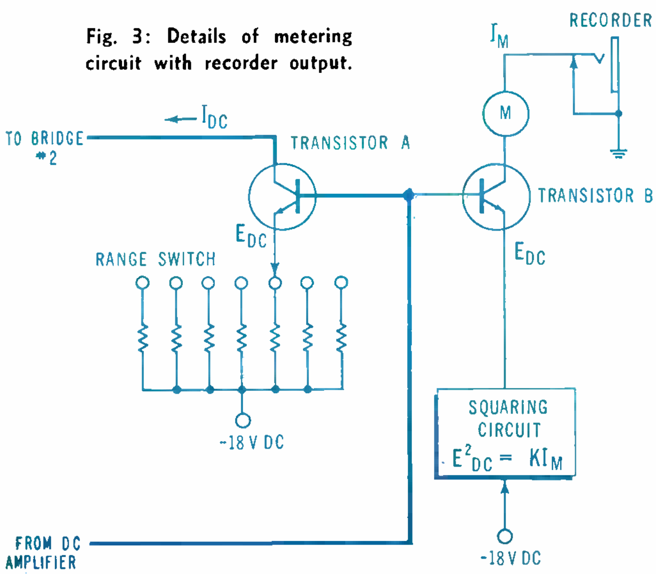
Now let's consider how the circuit reacts to temperature changes. If the temperature goes up, thermistor #1 needs less electrical power to bias it to the 100 Ω resistance which is required to maintain bridge #1 in a balanced condition. This means that I_{10KC} decreases in value. This same temperature change also occurs to thermistor #2 because it is in the same thermal environment as thermistor #1. If it is identical to thermistor #1 it also needs the same decrease in electrical power. It receives this decrease in power because I_{10KC} is applied to both thermistors through the primaries of their respective bridge transformers. This means that a temperature change would cause no change in I_{dc} which is the current used to activate the metering circuitry. It is important, however, that both thermistors share the same thermal heat sink.

Heat Sink

If the thermistor mount is connected to a piece of equipment being cycled in an environmental chamber, for instance, heat will travel up and down the waveguide or cable and the mount will tend to follow with an increase or decrease of temperature. The temperature change is a problem previously discussed, but also because flow of heat is involved there must also be temperature gradients present. If this gradient is 0.01°C. between the respective thermistor leads, a power meter drift of 3 μw will result. The thermal technique to overcome this effect is shown in Fig. 2. The leads of all thermistors are returned to the same thermal heat sink which is thermally isolated from the main thermal mass of the mount. Use of this technique makes it much more difficult to develop temperature gradients within the sink. It means that if the temperature of the main mass varies, the system would work as a thermal filter, greatly attenuating the thermal fluctuations which appear in the heat sink.

(*Continued on the following page*)

Fig. 3: Details of metering circuit with recorder output.



Thermal Drift *(Concluded)*

Other Design Benefits

Such an approach to thermal stability will also allow one to realize these other important advantages:

1) Greater sensitivity. A hundredfold decrease in thermal drift makes a more sensitive range possible.
2) Grounded recorder output. The current supplied by this recorder output would have to be linear in relation to the power being measured, so that microwave power would be a direct reading plot.
3) Zero set common to all scales. The device could be zeroed on the most sensitive scale and zero would be common to all higher scales.
4) A design capable of greater accuracy than the ±5% commonly available.
5) Portability. Battery operate the power meter so that it could be used in field applications.

The factor limiting power meter sensitivity is thermal drift. By making a hundredfold reduction in drift a ten times increase in power meter sensitivity would become reasonable, and measurements of as little as 1 μw feasible.

Fig. 3 shows the details of the metering circuit and the recorder output, driven by a current linear with the microwave power. I_{dc} is the dc current which is fed back to bridge #2. It is also equal to the RMS value of the microwave current. Microwave power is proportional to $(I_{dc})^2$. Therefore, a current proportional to $(I_{dc})^2$ is desired to drive a front panel meter and the recorder. The output of the dc amplifier, E_5, is applied to the bases of both transistor A & B. The emitter of transistor B is applied to a square root circuit which solves the formula

$$E^2{}_{dc} = KI_m$$

With the non-linear load in the emitter, it means that the collector current I_m is proportional to $(I_{dc})^2$ and, therefore, I_m would be proportional to the microwave power.

In Fig. 3, the zero is common to all ranges. Range changes are made by switching in the correct scale factor resistor into the emitter circuit of transistor A. When the meter is zeroed, I_{dc} is equal to zero; therefore, the voltage across the range switch resistor is also zero. Thus, the zero is common to all ranges.

Improved accuracy is obtained because each feedback loop has at least 60 db of gain. Accuracy is primarily dependent on the specification of various passive circuit elements. It can be expected to be better than ±3%.

Semiconductors make portability feasible. As active elements in this circuit design, transistors are an excellent prospect because of the circuit's low impedance levels; also, because the maximum frequency demands do not exceed the 10 KC of the oscillator circuitry.

Thus, using self-balancing bridge methods, coupled with newer thermal compensations and feedback circuit stabilization, an improved microwave power measuring design is possible with stable sensitivity on the order of 1 μw.

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Sophisticated Systems are . . . Eliminating

THE traveling-wave tube (TWT) amplifier is used mostly where broad bandwidths are required. Depending on the needs, tubes may be designed to provide large bandwidth (several tubes now exceed one octave bandwidth), high peak power (above 5 megawatts), or low noise figure (2db). Other needs may also affect design.

This article describes a tube for use in an application requiring 10% bandwidth and 5 kw of peak power. The noise figure is not a limiting factor.

What's so novel about a tube which falls so short of the state of the art in power? bandwidth? and noise figure? Stability, ruggedness, long life, and the ability to withstand environmental extremes may also limit use. All these factors, while important, have little to do with separating this tube from most others. It is for use in a system which can permit very little signal distortion. This requirement, while not unusual, is one of ever-increasing importance. It is especially so as more sophisticated systems are devised.

Gain and Phase

A distortion-free amplifier must have constant gain over the range of frequencies considered, as well as

Strange that with an art advanced to tubes with octave bandwidths, megawatts of peak power, and 2 db noise figures, we should apparently step backwards to a 10% bandwidth and 5 kw peak power. But the reason is simple —the new systems can tolerate very little distortion. Here's one approach!

Distortion in the TWT

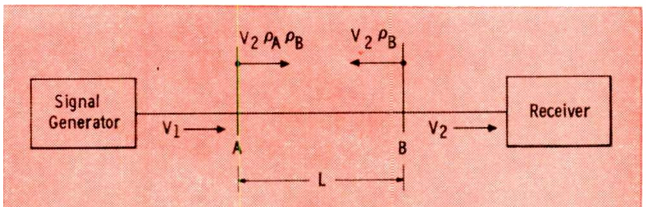


Fig. 1: Schematic of a transmission system with two reflections.

constant time delay, or a linear phase relationship with frequency independent of the drive level. Also, it must be free of intermodulation distortion. Fortunately, the physical phenomena which govern TWT operation do provide, to a first approximation, constant gain and linear phase. Gain is constant because a TWT is not a resonant device; phase is linear because all signals traverse the tube at about the beam velocity.

Gain and phase variation with input drive is not so well under control since a power amplifier must operate near saturation to provide reasonable electronic efficiency. The need to operate near saturation will also exert a profound influence on intermodulation distortion. However, this can be lessened some if the harmonics generated in the beam are negligibly coupled to the circuit.

Reflections

A major cause of distortion which can be brought under control is that which arises due to multiple reflections of the signal in the tube. If small reflections are set up at two points along a propagating system, they will act to set up a small additional wave which adds vectorially to the carrier.

Look at the system of Fig. 1. A signal from the generator propagates down a transmission line with small reflections at points A and B. Since the reflections are assumed to be small, the signal transmitted through the reflection points will be negligibly perturbed. The signal at the receiver will be the sum of the generated signal plus the small signal which has been reflected at the two reflection points. If V_1 is the generator signal at point B, and V_2 is the total signal transmitted through point B, we may write

$$V_2 = V_1 + V_2\,\rho_B\,\rho_A \qquad (1)$$

where, ρ_A and ρ_B are the voltage reflection coefficients at points A and B, respectively. Both reflection coefficients have included in them a phase factor corresponding to the phase shift between points A and B.

Eq. (1) may be rearranged in the form

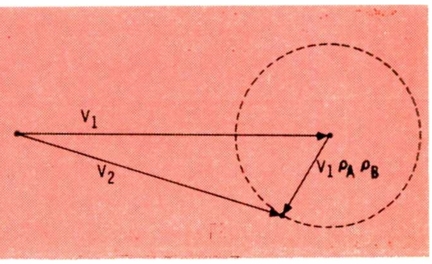
$$V_2 = \frac{V_1}{1 - \rho_A\,\rho_B} \qquad (2)$$

which is approximately

$$V_2 \cong V_1\,(1 + \rho_A\,\rho_B) \qquad (3)$$

The received wave is a distortion of the unperturbed transmitted waves which can be represented in a vector diagram, Fig. 2. The amplitude and phase of V_2 differ from that of V_1 in a cyclic manner which depends on the phase of the doubly reflected signal rela-

Fig. 2: Vector diagram showing phase and amplitude excursion of the transmitted wave.



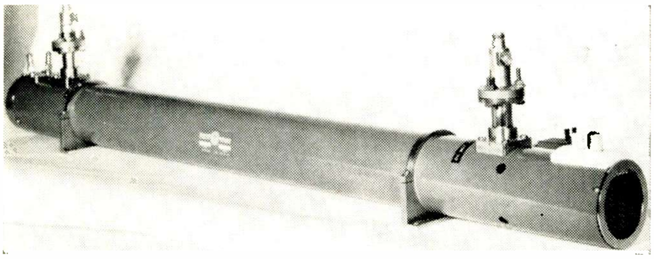


Fig. 3: Varian Associates' VA133 with type N adapter has 10% bandwidth, centered at 1320 MC; it's a 5-kw peak, 300 watt avg. amplifier.

Eliminating Distortion *(Continued)*

tive to the phase of V_1. A frequency change which will increase or decrease the effective distance between A and B by $\lambda/2$ will cause one complete rotation of the reflected signal vector.

The maximum excursion of the amplitude of V_2 is given by

$$\frac{V_{2\,max}}{V_{2\,min}} = \frac{V_1\,(1 + \rho_A\,\rho_B)}{V_1\,(1 - \rho_A\,\rho_B)} \qquad (4)$$

which may be expressed approximately in db in the form

$$\Delta\, V = 17.4\,\rho_A\,\rho_B\ \text{(db)} \qquad (5)$$

In the same manner, the maximum phase excursion may be written approximately

$$\Delta\,\phi = 115\,\rho_A\,\rho_B\ \text{(degrees)} \qquad (6)$$

The frequency interval over which the amplitude or phase will move from its maximum to minimum value is that for which the equivalent distance between reflections is changed by $\lambda/4$, i.e.

$$\frac{\Delta f}{f} = \frac{\lambda}{4\,L} \qquad (7)$$

As a numerical example, consider the case where the reflections have VSWR's of 1.2:1 and the distance between reflection is 10 wavelengths. Then from Eqs. (5), (6) and (7) we obtain approximately,

$$\Delta\, V = 0.143\ \text{db}$$

$$\Delta\,\phi = 0.95°$$

and

$$\frac{\Delta f}{f} = 2.5\%$$

Voltage and Loop Gain

If the signal were amplified in traveling from A to B and unattenuated in traveling from B to A, the situation would resemble that which exists in a TWT. Then Eqs. (5) and (7) would take the form

$$\Delta\, V = 17.4\, G\,\rho_A\,\rho_B\ \text{(db)} \qquad (8)$$

and

$$\Delta\,\phi = 115\, G\,\rho_A\,\rho_B\ \text{(degrees)} \qquad (9)$$

where G is the net voltage gain between A and B.

Where attenuation exists in the return path, G would be taken as the net loop gain. While the number of wavelengths along the forward path need not equal that along the return path, this fact is of little consequence to the foregoing argument and would usually result in a slight correction to Eq. (7).

A TWT may possess many internal reflections in addition to those at the input and output transitions. Each reflection must be minimized for optimum performance. The amplitude and phase change with frequency rate increases with the distance between reflections. Hence, the greatest effort should be made to minimize the reflections which are farthest apart. This is somewhat complicated because most TWTs contain one or more internal severs which prevent any of the signal reflected at the output from returning to the input. In any TWT, one is apt to find a lossless circuit section with 15 to 20 db of gain. If G is 10 and the two ends of the section cannot be matched to VSWR's better than 1.4:1, then the resultant amplitude excursion will be almost 5 db and the phase excursion will be about 32°.

Input and output transitions and internal terminations have been designed for this tube which possesses VSWR's less than 1.1:1 across the operating frequency band.

The tube, Fig. 3, is a 5-kw peak, 300-watt average power amplifier with 50 db minimum gain and 10% bandwidth, centered at 1320 MC. It is intended to operate with less than 1 db output power variation over the band with constant drive. Beam focusing is achieved using a periodic permanent magnet (PPM) stack.

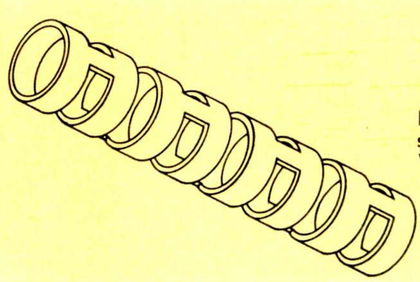


Fig. 4: Ring - bar structure used in the VA133.

PPM focusing was chosen for this tube because the required degree of beam confinement can rather easily be achieved using this method; because it is light and rugged; and, because it eliminates the need for a focusing supply. If a tube like this should be required for airborne service, a lighter PPM assembly could be designed to reduce overall weight to approx. 40 lbs. The tube, including magnet, has an overall length of 48 in. and a diameter of 4 in. It weighs 60 pounds and is water cooled.

Construction

The circuit used in the tube, Fig. 4, is a ring-bar structure. It was chosen because it possesses a high interaction impedance at a beam voltage suitable to the task of providing 5 kw of peak power. This circuit has a relatively low backward-wave impedance, an important factor in minimizing instability due to backward-wave oscillation. The circuit is supported by three ceramic rods which fit snugly inside the tube's vacuum envelopes. The circuit is made in three sections with two severs. Suitable lossy materials in the neighborhood of the severs act to terminate the r-f wave on the circuit.

Outside the tube envelope, but inside the focusing magnet pole pieces, is a water jacket which cools the tube envelope. This is run in series with the water-cooled collector. A water jacket inside the focusing magnet materially affects the size of the magnets required to focus the beam, because the body cooling system is occupying space which could be used by the magnet pole pieces. Therefore, the water jacket is designed to fit the tube as tightly as possible, consistent with obtaining the required coolant flow.

The outer jacket, surrounding the PPM stack, is a soft iron shield. This shield minimizes the effect of external magnetic fields as well as shields external equipment from the magnet fields of the PPM stack.

The electron gun is a convergent flow gridded gun using an oxidecathode. The grid bias for cutoff is about 1 volt per 100 volts of anode potential. The grid is pulsed 150 volts positive with respect to the cathode to obtain 2 amps of beam current.

Fig. 5 is a typical saturation curve showing the peak output power as a function of drive. The small signal gain is 60 db whereas the saturated gain is about 53 db. The maximum output power is 6.4 kw, an electronic efficiency of 30%.

Because the beam current and beam voltage are independently controlled, it is possible to vary the gain, bandwidth, power and efficiency over a wide range. The highest power is obtained at the low frequency end of the band with high beam voltage and current. The highest efficiency occurs near band center at slightly elevated beam voltage. The best broadband performance is achieved at lower beam voltage and higher beam current. Fig. 6 shows two curves of gains *versus* frequency at constant drive. At 10 kv beam voltage, the maximum variation in gain over the band is 0.4 db, whereas at 10.2 kv this figure rises to about 0.6 db. These curves show no significant fine structure. This small variation in gain attests to the adequacy of r-f matching.

A strong harmonic signal is a disadvantage in many applications. Since it may be inconvenient to filter out the harmonics, it is best that the amplifier produce a signal with negligible harmonic content. Fig. 7 is representative of the total second and third harmonic output. The harmonic content shown in this figure is low enough for most applications and small enough to guarantee that other power measurements made on a total power basis do not suffer in accuracy due to neglecting it.

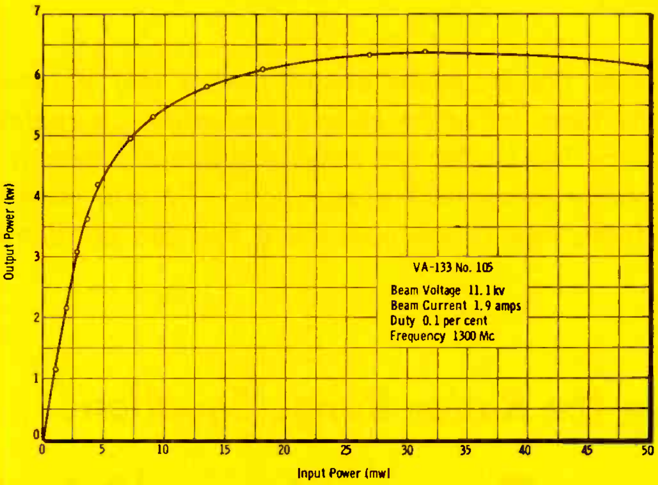


Fig. 5: Typical saturation curve showing the peak output power as a function of drive. Maximum output is 6.4 kw; efficiency, 30%.

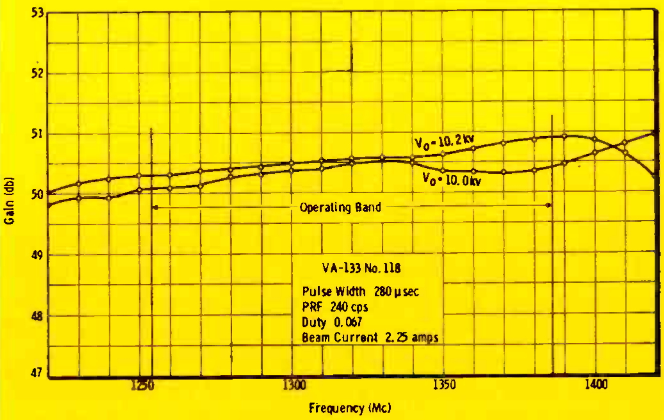


Fig. 6 (above): Small variation in gain attests to the adequacy of the r-f matching.

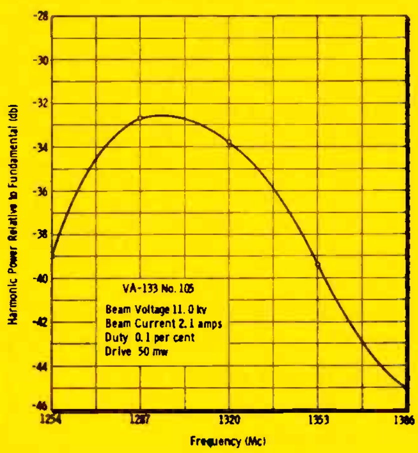


Fig. 7 (right): This curve is representative of the total second and third harmonic output in tube.

Future Developments

The development of this tube will form the basis for further work which is expected to yield a tube with the following characteristics:

Min. Peak Power	5 kw
Min. Average Power	1 kw
Bandwidth (1 db)	25%
Min. Gain	50 db
Min. Efficiency	30%
Max. Pulse Length	1 msec

Further in the future is the expectation of the resolution of thermal problems which presently limit the average power. There is little reason to doubt that this work will pave the way to the development of a 10-kw cw tube weighing no more than 40 lbs. including the PPM focusing stack. We believe that such a tube can be built with an overall efficiency in excess of 50%.

The author is indebted to Messrs. N. Vanderplaats and D. Lin for their invaluable assistance.

With the increased use of masers and parametric amplifiers, the term "effective noise temperature" is replacing "noise figure." Since this causes two sensitivity figures, there is much confusion— mainly in converting equations with one term to the other. Here's how to use each—and how the relationship is derived.

In the Radar Range Equation . . .

Equating 'Noise-Temperature' with

THE new low noise receivers for long range radar and communications systems require a second look at the present receiver terminology; especially, a look at the receiver noise figure. With the advent of masers, parametric amplifiers, tunnel diode amplifiers, etc., the term *noise figure* lost much of its significance. The term *effective noise temperature* has been replacing it.

Because there are now two receiver sensitivity notations, there is widespread confusion. The main problem is converting those which use noise figure to those using effective noise temperature. The expression for radar range is one such equation.

The old approximate equation

$$R_{max} = \sqrt[4]{\frac{P_t\, G_t\, G_R\, \lambda^2 \sigma}{(4\,\pi)^3\, kT_o\, BF}}$$

where,

P_t = peak transmitted power

G_t = transmitter antenna gain

G_R = receiver antenna gain

λ = wavelength

σ = target area

k = Boltzman's constant

B = bandwidth

F = receiver noise figure

T_o = 290°K

is completely erroneous because it sets the effective system temperature at 290°K. For many systems, however, especially those which employ low noise receivers, or scan at high elevations, this assumption is not true.

Elemental Question

The elemental question is—what is the maximum range which an arbitrary target can be discerned above external noise plus receiver noise. For a MDS (minimum discernible signal), target just distinguishable in the noise, the signal power and noise power (external plus receiver)[1] are about equal. In some systems, the signal power to noise power, S/N_o, must be a value greater than one to perform signal processing functions. Therefore, this ratio, S/N_o, is one of the main parameters to be considered. The factor S for radars is, of course

$$S = \frac{P_t\, G_t\, G_R\, \lambda^2 \sigma}{(4\,\pi)^3\, R^4}$$

and N_o is the total noise power contributed by all sources in the receiving system. Therefore, if

$$\frac{S}{N_o} = X \text{ or } S = N_o\, X$$

then the maximum range, R_{max}, may be expressed in terms of noise power and signal-to-noise ratio. R_{max} is then

$$R_{max} = \sqrt[4]{\frac{P_t\, G_t\, G_R\, \lambda^2 \sigma}{(4\,\pi)^3\, N_o\, X}}$$

[1] This assumes that the receiver has enough gain to mask the noise of the succeeding stages.

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'Noise Figure'

$$R_{\max} = C_1 \sqrt[4]{\frac{1}{N_o X}} \quad \text{where} \quad C_1 = \sqrt[4]{\frac{P_t G_t G_R \lambda^2 \sigma}{(4\pi)^3}}$$

Now $N_o = kBT_E$, and $T_E = T_A + T_S$

where

T_E = effective noise temperature of receiving system

T_A = antenna noise temperature

T_S = effective noise temperature of the receiver including lossy components between antenna and receiver

The antenna temperature,[2] T_A, is a function of what the antenna "sees," but generally consists of galactic, sun, earth, and absorption noise. The "noise power" that the antenna receives depends on the gain of the antenna and the direction in which it is pointing; or, in mathematical notation is

$$T_A = \sum_i \overline{T_i} \left[\overline{G_i} \frac{\Delta \theta_i}{4\pi} \right]$$

where $\overline{G_i} \frac{\Delta \theta_i}{4\pi}$ and $\overline{T_i}$ are average gain figures and temperatures, respectively, in the direction interval $\Delta \theta_i$.

One point which should be stressed is the noise received through the sidelobes, a deceiving amount, since a large percentage of the radiated energy is contained in the sidelobes.

Derivation

The effective noise temperature of the receiver can be derived from the basic definition of receiver noise figure.

[2] A better treatment of antenna temperature is given by Forward and Richey "Effects of External Noise on Radar Performance," *Microwave Journal*, Dec. 1960. Also, Hogg and Mumford, "The Effective Noise Temperature of the Sky," *Microwave Journal*, March 1960.

Long range search radar antenna made by Bendix for the AIR Force.

$$F_R = \frac{\dfrac{\text{signal power in}}{\text{noise power in}}}{\dfrac{\text{signal power out}}{\text{noise power out}}}$$

If the noise power out is greater than the amplified input noise power then F_R will be greater than unity indicating a more noisy receiver. Expressing this in terms of the above notation

$$F_R = \frac{\dfrac{S}{N_{in}}}{\dfrac{W_p S}{W_p N_{in} + W_p N_D}}$$

where

N_{in} = noise power into receiver

N_D = equivalent input noise power generated by receiver

W_p = gain of receiver

$$F_R = 1 + \frac{N_D}{N_{in}} \quad \text{or} \quad N_D = (F_R - 1)\, N_{in}$$

Now since both N_D and N_{in} may be considered forms of Johnson noise they are also equivalent to

$$\text{and} \quad \begin{aligned} N_{in} &= k\,BT_o \\ N_D &= k\,BT_R \end{aligned}$$

thus giving

$$\begin{aligned} k\,BT_R &= (F_R - 1)\, k\,BT_o \\ T_R &= (F_R - 1)\, T_o \end{aligned}$$

T_o by IRE definition is 290°K.

Therefore, the receiver noise temperature in terms of noise figure is

$$T_R = (F - 1)\; 290°\text{K}.$$

Noise Temperature *(Concluded)*

The noise temperature of the lossy components is by analogy

$$T_L = (L - 1)\ 290°K.$$

However, T_L and T_R cannot be directly added to T_A to determine T_E, the overall system noise temperature. The reason is as follows: When two elements are cascaded, the composite noise figure is generally expressed

$$F_{1+2} = F_1 + \frac{F_{2-1}}{G_1}$$

Here the losses, L, and the receiver noise figure, F, combine to give a composite noise figure, F_S, of

$F_S = L + L(F - 1)$ L multiplies $(F - 1)$ since it is actually a negative gain.

This reduces to

$$F_S = L(1 + F - 1) = LF$$

Again, by analogy,

$$T_S = (F_S - 1)\ 290 = (LF - 1)\ 290$$

This can be expanded to

$$T_S = (LF - 1 + L - L)\ 290$$
$$= [(L - 1) + L(F - 1)]\ 290$$
$$T_S = (L - 1)\ 290 + L(F - 1)\ 290$$

T_S then is $T_S = T_L + LT_R$

Therefore,

$$T_E = T_A + T_S = T_A + T_L + LT_R$$
$$= T_A + (L - 1)\ 290 + L(F - 1)\ 290$$

also

$$T_E = T_A + (LF - 1)\ 290$$

The range equation can now be expressed

$$R_{max} = C_1 \sqrt[4]{\frac{1}{k\,BX} \cdot \frac{1}{T_A + T_S}}$$

$$R_{max} = C_1 \sqrt[4]{\frac{1}{k\,BX} \cdot \frac{1}{T_A + T_L + LT_R}}$$

or in terms of noise figure

$$R_{max} = C_1 \sqrt[4]{\frac{1}{k\,BX} \cdot \frac{1}{T_A + (L - 1)\ 290 + L\ (F - 1)\ 290}}$$

A more manageable form would be

$$R_{max} = \sqrt[4]{\frac{P_t\, G_t\, G_R\, \lambda^2 \sigma}{(4\,\pi)^3\, k\, BX} \cdot \frac{1}{T_A + (LF - 1)\ 290}}$$

The equation is now in terms of the important parameters, S/N_o, noise figure, and/or effective noise temperature.

What's New

New Engineering Cuts Drafting

A NEW engineering method promises cuts in engineering, design and drafting costs from 33-50%.

Called the Panoramic Design Technique, the method was originated by T A B Engineers, Inc., 520 N. Michigan Ave., Chicago 11, Ill. It does away with drawings made by using conventional drawing boards, parallels, and T-squares. Instead, engineers now put their designs directly on wall-size blackboards and record them photographically.

T A B estimates that if the new technique were universally adopted, private industry and the government could slice at least $6-billion from their estimated annual $22-billion engineering, drafting, and research and development expense.

In its own use of the method, T A B has slashed both cost and time to complete projects for clients by approximately 50 per cent. On a special packaging machine for a food processor, T A B estimated it would take six months and $80,000 to engineer and build the machine conventionally.

Using the new technique, the completed machine was delivered in 90 days at a cost of $48,000.

The technique, developed over the past five years, is similar to "brainstorming" sessions used in advertising agencies.

In conventional engineering practice, the individual designer makes drawings of his ideas on his drawing board then submits them for approval or revision. There could have been as many as 10 or 20 engineers and designers working on parts of a design at the same time. And, the chief engineer has to look at their work individually.

When the basic design is developed, the work is turned over to detailers who spend hours preparing the detail and assembly drawings for use in making a pilot model.

Records show that an average of 78% of engineering time previously spent on a project was devoted to layout, detailing and revisions. This same drafting work, using the new method, is slashed to 34%.

With this new method, he continued, the fabrication of a better-engineered machine can be started much faster.

With the T A B method, the engineers and designers work together as a group at a huge blackboard. Each man is assigned a specific part of the design to develop, and his ideas are constantly on display as he progresses.

The director of engineering or project manager can see the project in its entirety instead of inspecting individual drawings one at a time. If a change is indicated, it can be made just by erasing the chalk and sketching a new version.

The change in the engineers' efficiency is revolutionary. By seeing how his portion of the design fits the whole pattern, he is stimulated to work better himself. And he can frequently help his fellow engineers on the board by suggesting improvements for their phase of the project.

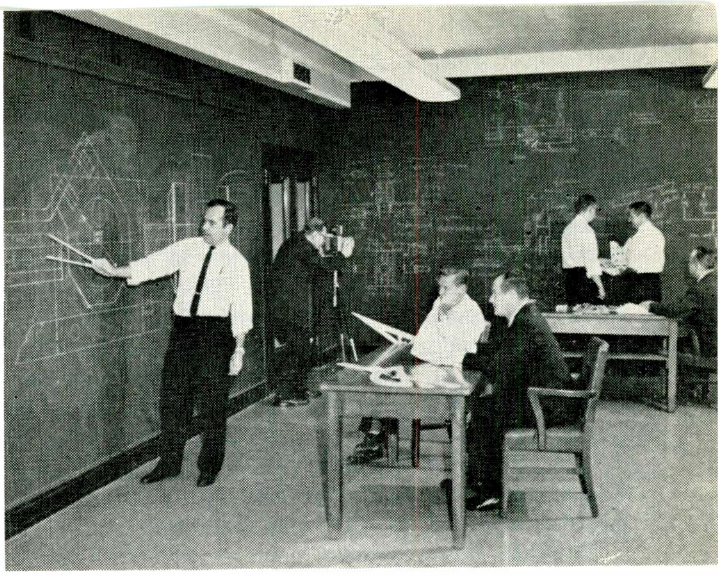
One caution. While the technique sounds simple, in actual practice it takes considerable skill to conduct properly. Getting the engineers and designers to accept the new method and acquire the proper new habits is one of the biggest challenges.

The blackboard technique has one important advantage which some engineers and designers may not want to acknowledge: *It forces them to work.*

It's hard to tell if a man at a drowing board or desk is studying a design or daydreaming or sleeping. He may puzzle over an idea for days before lifting a pencil. But he can't be idle at the blackboard. If he stands still, others will notice and they'll pitch in to help him. This is one of the big cost-saving advantages of the technique.

By sketching the basic design on the blackboard full-size or larger, the engineer can visualize the design more easily. He can also see how its component parts fit together. This in turn speeds the process of creative design.

When a satisfactory design is developed, a detailed drawing can be made immediately by the use of a plastic overlay which is already ruled and on which the engineer can sketch the other views and add dimensions.



Drawing boards are conspicuously missing in this engineering room where the Panoramic Design Technique is shown in action. Engineer at camera is preparing photograph design for a permanent record.

Instead of transferring this work to a drawing board, photographs are taken of the design.

First plans were to make blue-print size enlargements of the photographic print. But shop people found that the dimensions could be read right off the standard pocket-size print.

The requirements for the Panoramic Design Technique are wall size blackboards, drawing instruments made for blackboard use, photographic equipment, and the patience and skill to make the change from conventional engineering and design methods.

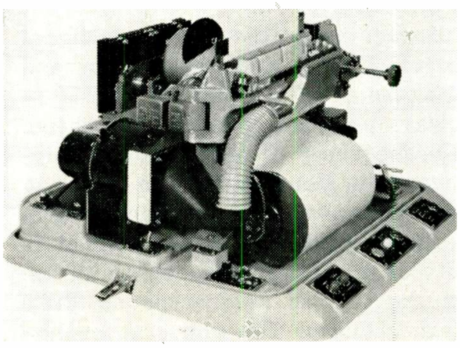
* * *

3,000-WPM Printer

Another high speed page printer, capable of producing 3,000 words per minute, has entered the field.

Developed for military teleprinter use and being readied for industry applications, the new unit is made by Motorola's Communications and Industrial Electronics Div., 4501 W. Augusta Blvd., Chicago 51, Ill. Designed for operation over cable, radio or telephone channels, it can be used in connection with computer print-out, and communications applications, where rapid transfer of records or information is required.

Interior of the new page printer shows the details of this completely dry process.



Speed and high reliability are achieved through the use of solid state electronics and a simplified non-impact mechanical operation. The printer provides a completely dry process, increasing reliability by eliminating any fixing step; the sheets can be instantly read while printing is taking place.

The basic system consists of a message buffer, translator and the printer. In a typical system, the information is stored in an external message buffer in its entirety prior to a print cycle. The print cycle may be simultaneous with the loading of another message in an alternate buffer.

Any data code can be used with the printer. Data code is converted to print code by the translator. These signals are then fed to a moving printing head where the alphanumeric characters are formed.

The unit has 3 separate, evenly-spaced, printing heads, which are attached to an endless belt running at a slow rate on an idler and driven pully. As one is leaving the right hand margin, the next head is entering at the left hand margin to print the next line.

All alphanumeric characters are composed out on a 35-dot matrix. The printing head has 7 "fingers" (styli) which sweep across the page forming the dots on white coated conductive paper. With the "Moving Matrix," print head, the fingers are brushed clean after each line of printing by passing the heads over brushes held in a miniature vacuum cleaning hood removing residue as quickly as it is formed.

Use of a "Moving Matrix" print head eliminates the need to set up a separate print head for each character position, reducing the extent of electronics and mechanics involved.

* * *

THE traveling-wave tube has always been known for its large bandwidth capability. However, present traveling-wave tubes which exhibit bandwidths comparable to that of waveguide or other passive microwave components are limited in power to only a few watts of average power. These power limitations arise from the use of a helix for the tube's interaction structure. A conventional TWT helix is shown in Fig. 1. Typically, the helix wire is only a few thousandths of an inch in diameter. It is supported inside the tube envelope on ceramic rods. The fragile nature of the helix and the poor heat dissipation capability of the supporting rods limits the average power which the TWT can generate.

To reach higher average power in a TWT a narrow-band periodically loaded waveguide has been used in place of the helix. A drawing of this type of interaction structure is shown in Fig. 2, and a photograph of the structure itself is shown in Fig. 3. To form this structure, a circular waveguide is periodically loaded with diaphragms which contain a center hole through which the electron beam passes, and a kidney-shaped microwave coupling hole. The details of this diaphragm can be seen in Fig. 3. The microwave signal propagates through the coupling hole, across the waveguide, and through the coupling hole on the opposite side of the next diaphragm, etc.

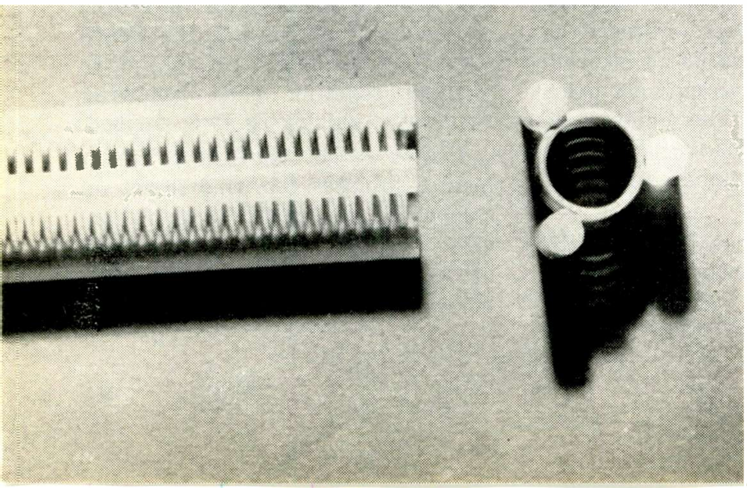
An alternate way of looking at this structure is to consider it as formed from a number of cylindrical microwave cavities periodically coupled by the kidney shaped coupling hole. Because of this latter way of picturing the structure, it is commonly called a "coupled cavity" interaction structure. The periodic nature of the loading results in a filter-type propagation characteristic, that is, propagation is only possible in a series of passbands.

Bandwidth Limitations

The rugged nature of this loaded waveguide, or coupled cavity, interaction structure has made possible the generation of kilowatts of average power from a TWT. However, until recently the bandwith of these high power tubes has been limited to only 10%, rather than waveguide bandwidth of about 40% which are typical of helix-type traveling-wave tubes.

To understand the reasons for the bandwidth limitations of the coupled cavity interaction structure, the basic process of TWT interaction must be considered. This basic process is that the microwave signal and the electrons in the electron beam "travel" through

Fig. 1: Helix is the conventional type found in normal TWT's.



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High Power

the interaction structure with the same velocity. Therefore, a given phase of the microwave field and a given bunch of electrons stay together and can interact over a considerable length of travel.

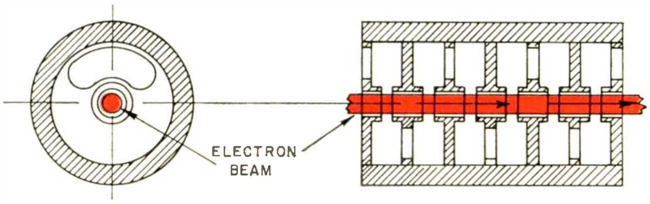


Fig. 2: Narrow-band periodically loaded waveguide has been used in place of a helix to reach higher average power.

Unlike the klystron-type of microwave amplifier, no resonant cavities are needed to form strong interaction fields over a short region, so the TWT by its very nature operates with non-resonant wide band structures. However, the interaction fields of the non-resonant TWT structure are much weaker than those of a klystron and so the interaction must occur over a long region in space. It is, therefore, necessary that the electron bunches stay in phase with the microwave signal for a long distance, and this requires that the velocity of propagation of the microwave signal must be very nearly the same as the velocity of the electron beam. It is this problem of synchronism between the velocity of the propagation of the microwave signal and the velocity of the electron beam that has limited the bandwidth obtainable from the coupled cavity interaction structure to only 10%.

The velocity of propagation of the microwave signal through the helix of Fig. 1 and the narrowband coupled cavity structure of Fig. 3 are compared in Fig. 4. The microwave propagation velocity is shown as a function of the frequency of the microwave signal. Shown for comparison along the bottom of Fig. 4 is the typical operating bandwidth of standard waveguide. As the frequency of the microwave signal is changed, its velocity of propagation through both the helix and through the coupled cavity-type of TWT interaction structure changes. However, the change

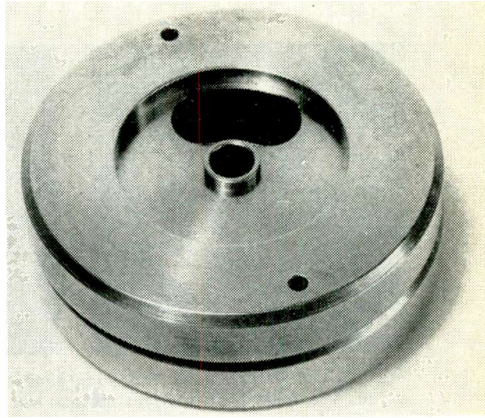


Fig. 3: Close - up shows the type of structure used in Fig. 2.

In the past, traveling-wave tubes were available for either high power or wideband applications. Now, with new techniques described here, both desirable features are available in one package.

TWT's with Wide Bandwidths

is much less for the helix, in fact over the entire waveguide bandwidth the change is only about 10%.

An Improved Structure

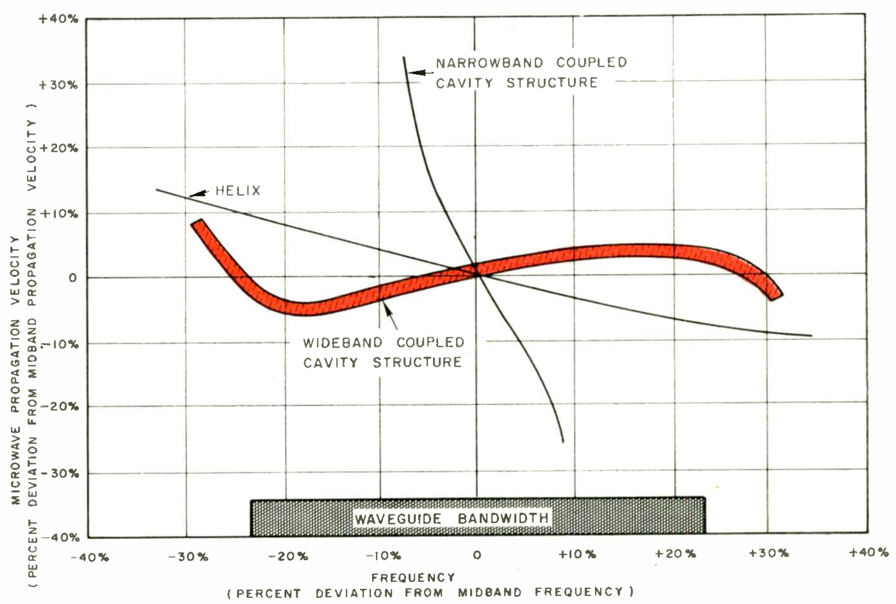
Until recently, therefore, the user of a traveling-wave tube was limited to one of two choices. He could have either bandwidth comparable to waveguide and other passive microwave components at low average power levels, or, he could have high average power by using the coupled cavity-type TWT, but only at bandwidths of about 10%. Now, however, the bandwidth capabilities of the coupled cavity structure have been greatly improved, to become comparable to those of a helix. The improved structure which makes this possible is compared to the old type of structure in Fig. 5. The section on the left is the same as that shown in Fig. 3 and is limited in bandwidth to only 10%. The improved section is shown on the right.

The propagation velocity of this improved broadband circuit is compared to the older narrowband loaded waveguide circuit and to the helix in Fig. 4. The improved circuit is seen to have even less variation in propagation velocity than the helix over the entire waveguide bandwidth range. This improvement has been obtained by increasing the coupling between the cavities to increase the bandwidth of the structures propagation passband, and by shaping the coupling hole to obtain the desired propagation velocity characteristics.

Design improvements were also necessary to match from external waveguide to the broader band structure and to suppress spurious oscillations. These improvements have been accomplished with the result that the bandwidth, heretofore possible only with the fragile helix structure, can be obtained with the rugged power handling capability of the coupled cavity interaction structure.

A typical application of this type of broadband coupled cavity interaction structure to a high average power traveling-wave amplifier is shown in Fig. 6. This traveling-wave amplifier provides 1 kw of peak output power over the X-band frequency range from 7.8 to 11.4 KMC. The tube has 40 db gain and so can be driven from a 100 mw source. The electron gun is grid controlled so that the high power electron beam can be modulated on and off with the application of a pulse voltage of only about 250 volts. The electron beam is focused with periodic permanent magnets, so that the entire tube, including its focusing structure, weighs only 15 lbs. The tube is air cooled. It can be operated at an average output power of 50 watts, this limitation being imposed by the gridded gun and not by the interaction structure. A cross sectional drawing of this tube is shown in Fig. 7. The electron beam

Fig. 4: The velocity of a microwave signal through various structures are compared.



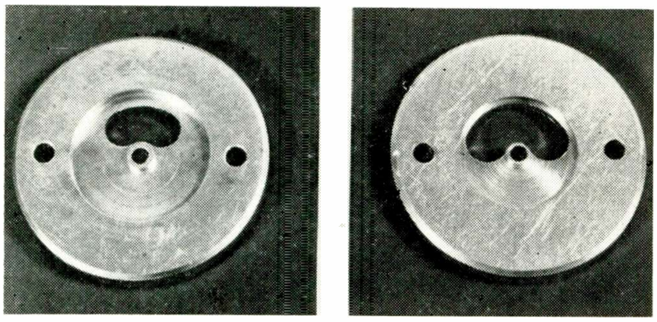


Fig. 5: The narrow-band and wide-band structures are compared. The wide-band cavity structure has the larger opening.

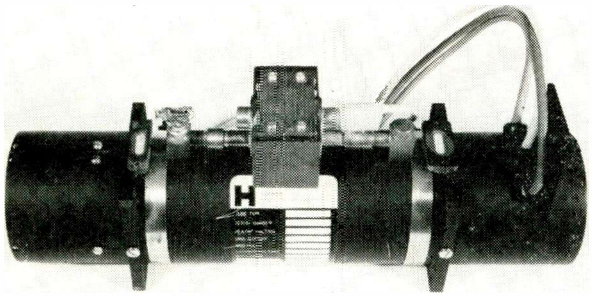


Fig. 6: The application of a broad-band structure is shown.

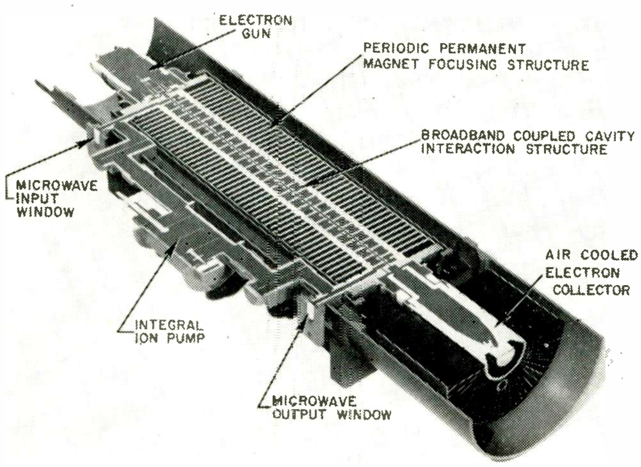
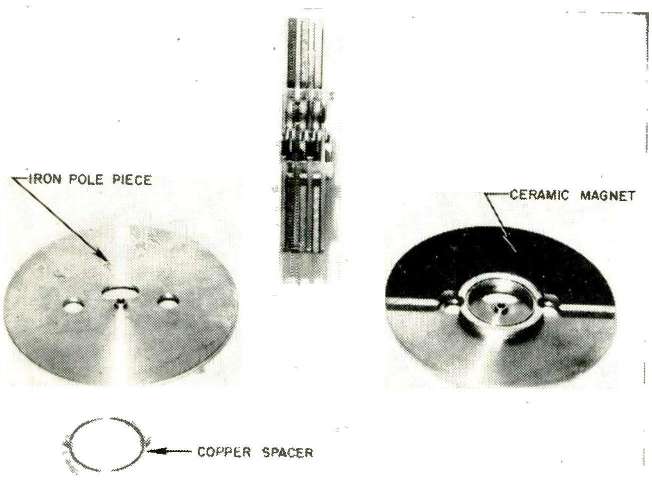


Fig. 7: Cross sectional drawing of the TWT shown in Fig. 6.

Fig. 8: Further details of the design which combines the ppm focusing into the broad-band couplied cavity is shown.



High Power TWT's (Concluded)

is formed by the electron gun and focused by the periodic permanent magnets through the interaction structure to the collector. The input microwave signal enters through the input window, interacts with the electron beam in the interaction structure, and the amplified signal passes out through the output window. Also, the tube is equipped with an integral electronic vacuum pump to insure that the tube can never become gassy.

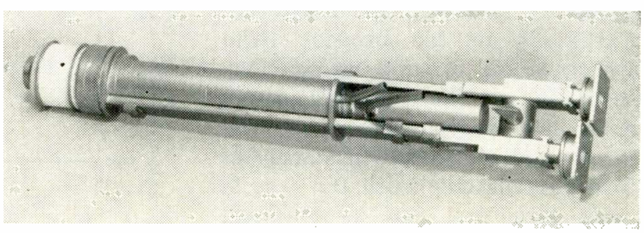
Further details of the design which combines the periodic permanent magnet focusing into the broad-band coupled cavity structure are shown in Fig. 8. The cavity of the microwave interaction circuit is formed with copper spacers and iron pole pieces. The copper spacer forms the outer wall of the cavity and also serves as a vacuum seal. Outside this spacer, and so outside the vacuum system, fit ferrite ceramic magnets. The magnetic field is carried from the magnets by the pole pieces to the electron beam. Using the r-f drift tubes for the ferrules of the periodic focusing structure permits the magnet period to be made very short, which results in very tight focusing.

Another type of traveling-wave amplifier made possible by the use of the broad-band coupled cavity interaction structure is shown in Fig. 9. In this X-band traveling-wave amplifier the periodic permanent magnet focusing is replaced by solenoid focusing, and the entire interaction structure made of copper to increase its heat dissipation capability. This tube provides the same 1 kw of peak power over the same wide bandwidths with the same 40 db of gain as the previous tube. However, as a result of the all copper construction and solenoid focusing, this tube can be operated at any duty cycle up to CW, to provide as high as 1 kw of average X-band power. This is several orders of magnitude more average power than could be obtained from a helix-type tube.

Conclusions

The broadband coupled cavity-type of TWT interaction structure described above has made possible traveling-wave amplifiers with bandwidths comparable to that of waveguide, or other passive microwave components commonly used in microwave systems at the kilowatt average power level. Already this circuit has been incorporated into practical X-band traveling-wave tubes, with the result that the microwave system designer now has high average power transmitter tubes available whose bandwidth is comparable to that of the other microwave components in his system.

Fig. 9: Another type of TWT made possible by the use of the broad-band coupled cavity interaction structure.



Solid state devices have many new applications for the control of microwave energy. Methods for improving transmission rates, reduction of weight and size, and increased reliability are discussed.

Solid State Control of Microwaves

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MOST publicity in the advances of solid state electronics has emphasized the transistor. The semiconductor junction diode has found great use as a power rectifier, and a fast switch for computer applications. The importance of point-contact diodes for microwave detection is also well recognized. More recently, semiconductor diodes have been used for the control of microwave energy, permitting the construction of novel types of switches, phase shifters, duplexers, and other microwave components. These components provide the reliability of solid state devices required in electronic systems; they have the speed of operation necessary for high transmission rate communication systems, and are light and compact for airborne and missile applications.

Typical applications include the use of a single-pole single-throw switch as a variable attenuator for amplitude modulation of r-f energy, and of multiple-throw switches to connect between multiple loads or feeds. Semiconductor switches can also be used in stepping types of phase shifters or a continuously variable phase shifter can be constructed by utilizing the variable reactance properties of junction diodes. The reactance of these diodes is also a function of r-f power level and this effect can be utilized to construct crystal-protecting power limiters, or complete diode duplexing systems.

Typical performance capabilities of available solid state devices are as follows:

1. *Switches:* Switches having bandwidths of from 5% to over an octave have been constructed with power handling capability of 150-watts peak and several watts CW. Frequency of operation of these switches is from 100 Mc to 12,000 Mc, and the switches have been constructed in both coaxial line and waveguide. Special switches have been constructed which can handle up to 10 kw peak power.
2. *Limiters:* Power limiters have been constructed with bandwidths of from 5% to 30% having power capability of 5 kw peak, and 30 watts CW. Output power is limited to safe levels for detector crystals. Frequency of operation of these devices has been from 100 to 3000 Mc.
3. *Duplexers:* Duplexers having bandwidths of from 5% to 20% with power handling capabilities of 10 kw peak and 30 watts CW have been built. Frequency of operation of these devices is from 200 to 1500 Mc.

When a diode is inserted in series or in shunt in a transmission line, r-f power incident on the diode is reflected by, absorbed in, or transmitted past the diode. In an ideal diode switch the incident power is

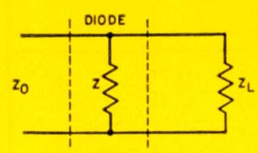


Fig. 1: Shunt switch schematic.

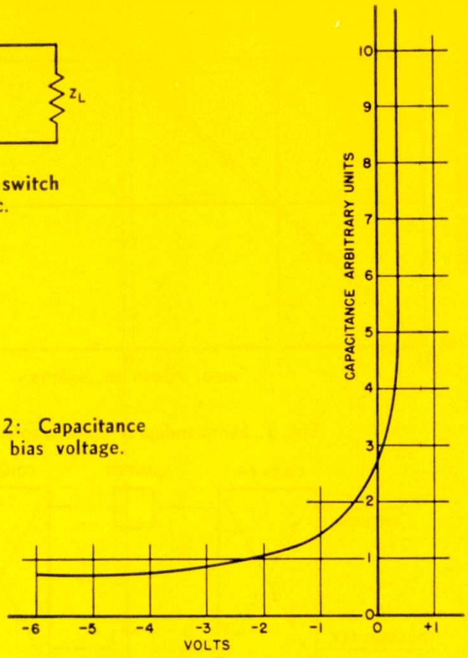


Fig. 2: Capacitance vs. bias voltage.

Control of Microwaves

(Concluded)

either completely reflected or completely transmitted and practical diode switches absorb very little of the incident power. As an example, consider a switch which uses a variable reactance type diode (varactor) in shunt with a coaxial line. As shown in Fig. 1, if the diode exhibits high impedance it has little effect on the power transmitted to the load. For an impedance, Z, the insertion loss obtained with the generator, and the load matched to the characteristic impedance of the line is

$$I.\ L. = 1 + \frac{Z_o^2}{2Z}$$

The switching properties of the network can be evaluated by inserting this equation the appropriate impedance values for the diode network in both the "on" and "off" conditions. A typical diode capacitance-voltage characteristic is shown in Fig. 2. Under forward bias conditions, the diode exhibits a large capacitance and resulting low reactance; thus most of the power is reflected because the diode impedance is much less than the load impedance. Under reverse bias conditions, the diode exhibits a small capacitance, or a high reactive impedance, allowing the power to be transmitted to the load with small loss.

Other types of semiconductor switches utilize different circuit configurations or different diode properties depending on the switch characteristics desired, such as, insertion loss, switching isolation, bandwidth and switch configuration. Fig. 3 shows the performance characteristics of a typical broadband switch for a device operating at S-band. Within the range of operation of the diode switches, they offer significant advantages over other devices. Most striking is the switching speed, which is on the order of nanoseconds. These switches are characterized by very small size and light weight, and the driving power to obtain switching action is only tens of milliwatts. Thus, multiple-throw switches requiring relatively modest switching power and with light weight and small size become feasible.

The varactor diode exhibits a change in impedance in response to an applied r-f voltage, in addition to the dependance on applied DC voltage. Thus, the diode impedance changes as a function of r-f power level. By placing such a diode in shunt across a transmission line, a limiter can be constructed having characteristics as shown in Fig. 4. At low power levels, the varactor reactance is tuned with a shunt inductance and presents a very high impedance across the line; thus, the insertion loss is very small. At power levels above a few milliwatts the diode capacitance increases (decreasing the shunt impedance) and the insertion loss increases with increasing power. This maintains the power output essentially constant. This simple limiter is of great value as a receiver protector.

The varactor power limiter, similar to the semiconductor switch, operates by reflecting the incident power. This makes possible the construction of a complete solid state duplexer by utilizing a circuit such as that shown in Fig. 5. At high power levels, the varactor diode reflects the transmitter power and the output emerges from the antenna terminals. The low power received by the antenna passes through the shunt diodes with low loss and emerges at the receiver terminals.

This technique permits the construction of completely solid state duplexers of very light weight and fast response.

The devices described here are only representative of the many new components which can be constructed with the help of new semiconductor technology. Current development work is aimed at improving the performance of these devices, extending operation to higher frequency with lower insertion loss, and obtaining suitable performance at higher peak and average power levels. These devices have already found an important place in electronic systems as substitutes or replacements for mechanical switches and gas devices. In some cases, equivalent performance could not be obtained with previously existing devices.

Fig. 3: Single pole- single throw S-band diode switch characteristics.

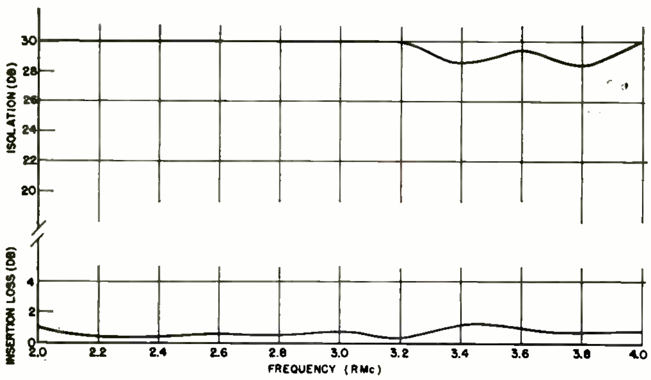


Fig. 4: Coaxial line varactor limiter, characteristic frequency, 1,000 Mc.

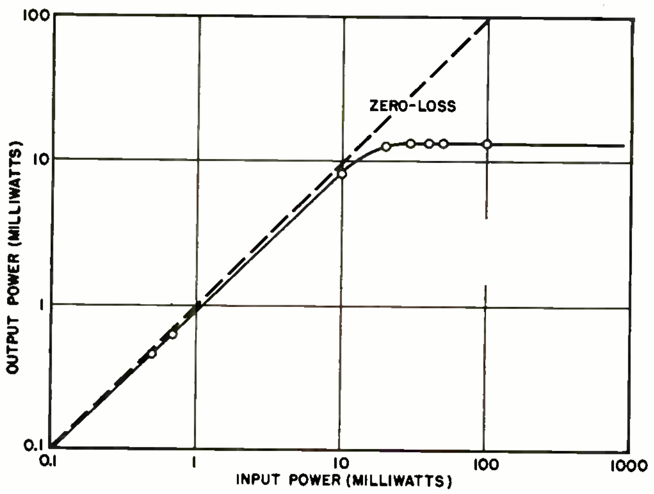
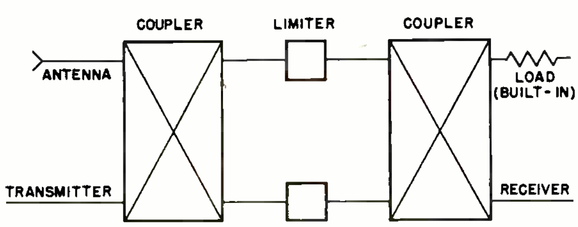


Fig. 5: Semiconductor diode duplexer.



Page from an Engineer's Notebook

#60—Transmission Line Nomograph

By **ALLAN LYTEL**
Manager-Publications
Electronics and Ordnance Div.
Avco Corporation
2630 Glendale-Milford Rd.
Cincinnati 41, Ohio

To find the input impedance Z_o of a line of given length L knowing the type of load termination Z_L and the frequency F from 150 MC to 3000 MC.

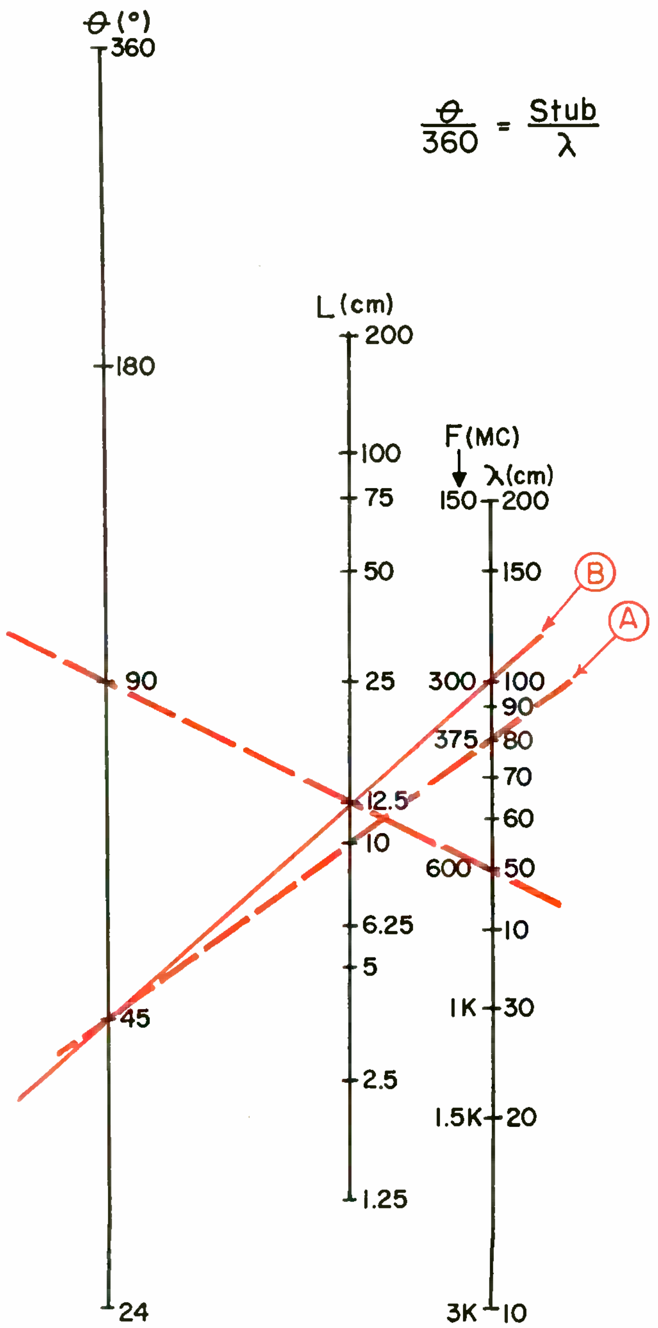


Chart 1 shows θ, L, F, and λ.

To find the length of a section of transmission line knowing wavelength in centimeters and stub length in centimeters.

Set rule over stub length L and λ to read θ in degrees. If $\lambda = 50$ cm and the stub is 12.5 cm, θ is 90°. The stub is 90 electrical degrees long or ¼ λ.

If $\lambda = 80$ cm and the stub is 10 cm, $\theta = 45°$.

Chart 2 shows Z_{in} in terms of Z_o and θ.

Case I: $Z_L = \infty$ (open line).

1. Using chart 1, set rule at F which is also λ.
2. Read λ in cm.
3. Set rule over λ and L to read θ or line length in degrees.
4. Measure θ in degrees on Chart 2. Where θ crosses $Z_L = \infty$, this is the Z_{in} for an open-circuited line.

Example A: $F = 80$ MC, $L = 10$ cm., $Z_L = \infty$.

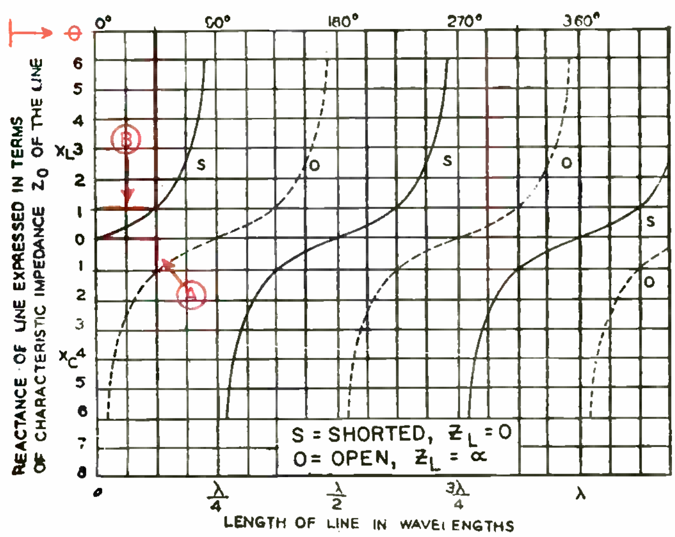
1. The line from F to L shows $\theta = 45°$ on Chart 1.
2. On Chart 2, 45° in and down to $Z_L = \infty$ shows $Z_{in} = -1.0\ Z_o$. If $Z_o = 100$, $Z_{in} = -100\ \Omega$ or $100\ \Omega\ X_c$.

Case II: $Z_L = 0$ (shorted line).

1. With the same steps as above read the intersection of θ and $Z_L = 0$. For the same values as above (Case I) $Z_{in} = +100\ \Omega$ or $100\ \Omega\ X_L$.

Chart 1 (left): Colored rules show how to use graph. Unlettered rule is basic example; letters refer to specific examples in text.

Chart 2 (below): Again the letters refer to specific examples in text.



Transmission Line

Nomograph *(Concluded)*

Case III: $Z_L = \infty$ (open line).

1. Find X_C or X_L.
2. Read in Chart 2 until the first corresponding X_L or X_C is reached. This is β or length of "apparent stub" which is exactly equal to $\pm X$, the termination of the real line.
3. Find θ, actual length, as in Case I above.
4. Add θ and β to get new total angle ϕ.
5. Read, from Chart 2, the Z_{in} for a line of this length with *either* $Z_L = \infty$ or $Z_L = 0$ depending upon which resulted in step 2.
6. This is the line which behaves exactly as does the problem where $Z_L = \pm X$.

Example B: $F = 300$ MC, $X_L = 100\ \Omega$, $Z_o = 100\ \Omega$, $L = 12.5$ cm.

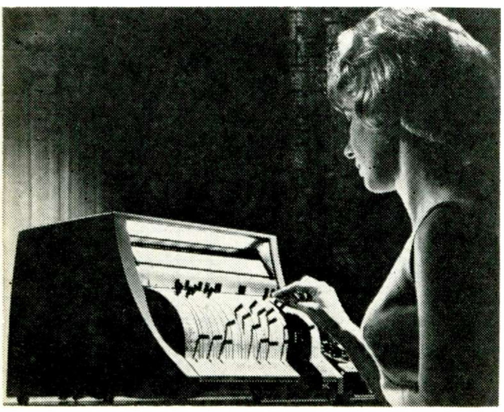
1. Read 100 Ω on first X_L curve (solid line) and find this is 45° or β.
2. From Chart 1, with $L = 12.5$ cm and $F = 300$ MC, $\theta = 45°$.
3. $\theta + \beta = \phi\ 90°$.
4. From Chart 2, 90° in on solid line is infinite X_L which is parallel resonance.
5. Thus, this line, terminated by X_L is a parallel tuned circuit resonant at 300 MC.

Computer Inquiry Features Automatic Voice Replies

An economical computer inquiry device enables transmission of quiries to a UNIVAC Real-Time Computing System from a remote location and—for the first time in the history of data communications—reception of stored computer-generated voice replies to the questions.

Unicall was introduced by the Remington Rand UNIVAC Div. of Sperry Rand Corp. during the dedication of the new Remington Rand UNIVAC Engineering Center at Whitpain Township, Pa. It is expected to simplify and accelerate updating and reporting of changes in inventory, production, distribution and sales in many businesses and industries.

Less than 5 seconds after the inquiry message, composed by positioning levers, is transmitted, a computer-generated voice reply is received on phone adjacent to set.



Unicall is a by-product of the Airline Interline Development System (AID), also originated by Remington Rand UNIVAC. Adoption of the AID plan could eliminate many of the difficulties and delays which now plague interline reservations or the sale of space between airlines.

Answers to pertinent questions which can be posed are stored on a magnetic drum at the computer site. After a message has been processed, the computer selects the appropriate reply from the drum and sends it back over the telephone lines. Less than 5 seconds are required for this whole transaction.

Forty sliding levers on the face of the set can be positioned to correspond to individual letters or numerals in a specific message or query. This lever-setting operation is simplified by a format guide mounted at the top of the panel. A message display window enables the operator to corroborate his selection of numerals and letters before the message is transmitted. This feature is made possible by a digit display wheel which is geared to each positioning lever.

After the appropriate lever selections have been made, the operator is ready to send his message to the computer. This is done by dialing the computer on the telephone. When the connection has been made with the computer, an acknowledgement signal is fed back into the set. Receipt of this signal trips a scanning mechanism and the message itself is transmitted at the rate of 20 characters per second over the telephone network.

Responses to queries are made in seconds. The transfer of information from the Unicall set to the computer can be completed in 2 seconds. Then the voice reply begins immediately and takes from 3 to 5 seconds to transmit. A few of the checks which the computer makes before answering each message are:

1) Determines if 44 valid characters have been received, i.e., 3 identification digits, 40 message digits, and 1 "end-of-message" or "more follows" digit.

2) Makes sure that the message itself is complete and complies with the required format associated with the particular type of transaction.

3) Establishes whether additional messages relating to the ones received are or are not forthcoming.

4) Corroborates that the message is not a duplication of a previous transaction.

When these message validity checks are completed, the computer selects and transmits the appropriate voice reply to the telephone connected with the Unicall set. As soon as the pre-recorded answer has been transmitted, another signal is generated which disconnects the set from the line and makes the line available to other users.

★ ★ ★

ELECTRONIC INDUSTRIES'

1962 Directory of Microwave Equipment Manufacturers

Names and addresses of electronic companies making the principal microwave products for today's markets. Section 1 gives complete alphabetical listing of all active companies. All these firms have provided verified product listings. In Section 2 these firms are again listed and identified with the specific products that they manufacture.

ACF Electronics Div ACF Industries Inc 11 Park Pl Paramus NJ
Adams Russell Co Inc 200 6th St Cambridge 42 Mass
Ad-Yu Electronics Lab Inc 249 Terhune Ave Passaic NJ
Ainslie Corp 531 Pond St S Braintree 85 Mass
Airborne Instruments Lab Div Cutler Hammer Inc Comac Rd Deer Park LI NY
Aircraft Armaments Inc Industry Lane Cockeysville Md
Airtron a division of Litton Ind 200 E Hanover Ave Morris Plains NJ
Airtec Inc 139 E 1st Ave Roselle NJ
Airtronics Inc 5522 Dorsey Lane Bethesda Md
Alford Mfg Co 299 Atlantic Ave Boston 10 Mass
Alfred Electronics 879 Commercial St Palo Alto Calif
Alpar Mfg Corp 220 Demeter St Palo Alto Calif
American Machine & Foundry Co Gen Eng Labs 11 Bruce Pl Greenwich Conn
American Radar Components Inc 415 E Main St Denville NJ
Amperex Electronic Corp 230 Duffy Ave Hicksville NY
Amp Inc Capitron Div 155 Park Ave Elizabethtown Penna
Andrew Antenna Corp 606 Beech St Whitby Ont Canada
Andrew Corp PO Box 807 Chicago 42 Ill
Andrew California Corp 931 Marylind Ave Claremont Calif
Antenna & Radome Research Assoc 1 Bond St Westbury NY
Antenna Specialists Co 12435 Euclid Ave Cleveland 6 Ohio
Antlab Inc 6330 Proprietors Rd Worthington Ohio
ARF Products Inc 7627 Lake St River Forest Ill
Associated Electrical Industries Ltd Carholme Rd Lincoln England
Associated Electrical Industries 33 Grosvenor Place London SWL Great Britain
Automation Dynamics Corp 255 County Rd Tenafly NJ
Autonetics Div North American Aviation Inc 9150 E Imperial Hwy Downey Calif
Beauchaine & Sons Inc Lakeport NH
Belz Industries Inc 89 Union St Mineola LI NY
Bendix Corp Bendix Pacific Div 11600 Sherman Way N Hollywood Calif
Bendix Corp 1104 Fisher Bldg Detroit 2 Mich
Bendix Corp Red Bank Div RT 35 Eatontown NJ
Birdair Structures Inc 1800 Broadway Buffalo 12 NY
Blaw-Knox Co 300 6th Ave Pittsburgh 22 Penna
Bogart Mfg Corp 315 Seigel St Brooklyn 6 NY
Bomac Labs Inc Salem Rd Beverly Mass
Boonton Radio Corp Intervale Rd Boonton NJ
Breeze Corp 700 Liberty Ave Union NJ
Brooks & Perkins Inc 1950 W Fort Street Detroit 16 Mich
Budd Stanley Co 43-01 22nd St Long Island City NY
Budelman Electronics Corp 375 Fairfield Ave Stamford Conn
Burndy Corp/Omaton Div Richards Ave Norwalk Conn
Cable Electric Products 234 Daboll St Providence 7 RI
Canadian Applied Research Ltd 750 Lawrence Ave W Toronto Ont Canada
Canadian Marconi Co 2442 Trenton Ave Montreal 16 Que Canada
Canoga Div Underwood Corp 15330 Oxnard St Van Nuys Calif
Cascade Research Div Lewis & Kaufman Electronics Corp 5245 San Fernando Rd W Los Angeles Calif
Caswell Electronics Corp 414 Queens Lane San Jose 12 Calif
Chu Associates PO Box 387 Whitcomb Ave Littleton Mass
Chemalloy Electronics Corp Gillespie Airport Santee Calif
Communications Co 300 Grecp Ave Coral Gables Fla
Control Electronics Co Inc 10 Stepar Pl Huntington Sta NY
Co-Operative Industries Inc 100 Oakdale Rd Chester NJ
Corbin Corporation 26 Primrose Lane Levittown NJ
Corning Electronic Components Bradford Penna
Cubic Corporation 5575 Kearny Villa Rd San Diego 11 Calif
Custom Components Inc PO Box 248 Caldwell NJ
CWS Waveguide Corp 301 W Hoffman Ave Lindenhurst NY
Dage Electric Co Inc Beech Grove Ind
Dahlstrom Metallic Door Co Buffalo & 2nd Sts Jamestown NJ
DBM Research Corp PO Box 521 Cocoa Beach Fla
Demornay-Bonardi Corp 780 S Arroyo Pkwy Pasadena Calif
Dittmore-Freimuth Corp 2517 E Norwich St Milwaukee 7 Wis
Dow-Key Co PO Box 711 Thief River Falls Minn
Dresser Ideco Co 8909 S Vermont Los Angeles Calif
Dumont Labs Inc Allen B 750 Bloomfield Ave Clifton NJ
Dymec Div Hewlett Packard Co 395 Page Mill Rd Palo Alto Calif
Dynatronic Inc 717 W Amelia Ave Orlando Fla
Edgerton Germeshausen & Grier Inc 160 Brookline Ave Boston 15 Mass
Egan Laboratory 107-56 113th St Richmond Hill 19 NY
Eitel-McCullough Inc 301 Industrial Way San Carlos Calif
Electro Impulse Lab Inc 208 River Street Red Bank NJ
Electromagnetic Technology Corporation 1375 California Ave Palo Alto Calif
Electronics Development Co 3734 Cahuenga Blvd N Hollywood Calif
Electronic Specialty Co 5121 San Fernando Rd Los Angeles 39 Calif
Elliott Brothers London Ltd Radar Div Elstree Way Borehamwood Hertfordshire England
Emerson & Cuming Inc 869 Washington St Canton 1 Mass
Empire Devices Products Corp 37 Prospect St Amsterdam NY
Enflo Corp Fellowship Rd Route 73 Maple Shade NJ
Farinon Electric Co 416 D St Redwood City Calif
Ferranti Electronic Inc 30 Rockefeller Plaza New York 20 NY
Filmohm Corporation 48 West 25 St New York 10 NY
Filtron Co Inc Western Div 10023 W Jeferson Blvd Culver City Calif
Filtron Co 131-15 Fowler Ave Flushing 55 NY
Formcraft Tool Co 2464 S Archer Ave Chicago 16 Ill
Foto Video Labs 36 Commerce Rd Cedar Grove NJ
Frequency Standards Div Harvard Industries Inc Box 504 Asbury Park NJ
FXR Inc 25-26 50th St Woodside 77 NY
Gabriel Electrones Div Gabriel Co Millis Mass
Gavitt Wire & Cable Co 455 N Quince St Escondido Calif
General Cable Corp 730 3rd Ave New York 17 NY
General Communication Company 677 Beacon Street Boston 15 Mass
General Electric Co Power Tube Dept Palo Alto Calif
General Electric Co HMEE Dept Syracuse NY
General Electric Co Communication Products Dept Lynchburg Va
General Mills Inc 1620 Central Ave Minneapolis 13 Minn.

Microwave Manufacturers, A-Z

(Continued)

General Radio Co 22 Baker Ave West Concord Mass
Gombos Inc Co John Webro Rd Clifton NJ
Goodrich Sponge Products B F Div B F Goodrich Co Canal St Shelton Conn
Gorham Electronics Div Gorham Mfg Co 333 Adelaide Ave Providence 7 RI
GPL Div General Precision Inc 63 Bedford Rd Pleasantville NY
Granger Associates 966 Commercial St Palo Alto Calif
Gulton Industries Inc 212 Durham Metuchen NJ
Hallamore Electronics Co 714 N Brookhurst Anaheim Calif
Hallicrafters Co 4401 W 5th Ave Chicago 26 Ill
Hammarlund Mfg Co 460 W 34th St New York 1 NY
Hazeltine Electronics Div/Hazeltine Corp 59-25 Little Neck Pkwy Little Neck 62 NY
Hitemp Wires Co/Div Simplex Wire & Cable Co 1200 Shames Dr Westbury NY
Hoffman Electronics Corp 3761 S Hill St Los Angeles 7 Calif
Hughes Components Div Bldg 20 Room 1372 Culver City Calif
Hycon Mfg Co 1030 S Arroyo Pkwy Pasadena Calif
Hycon Mfg Co 700 Royal Oaks Drive Monrovia Calif
Intraspace Corp 135 Orange St Bloomfield NJ
ITT Labs 500 Washington Ave Nutley NJ
ITT Federal Div ITT Corp 100 Kingsland Rd Clifton NJ
I-T-E Circuit Breaker Co 601 E Erie Ave Phila 34 Penna
J-V-M Microwave Co 9300 W 47th St Brookfield Ill
Kay Electric Co Maple Ave Pine Brook NJ
Kearfott Div General Precision Inc 1150 McBride Ave Little Falls NJ
Kearfott Div General Precision Inc 253 N Vinedo Ave Pasadena Calif
Kearfott Div General Precision Inc 14844 Oxnard St Van Nuys Calif
Kepco Inc 131 38 Sanford Ave Fushing 55 NY
Laboratory for Electronics Inc 719 Beacon St Boston 15 Mass
Lavoie Labs Inc Matawan-Freehold Rd Morganville NJ
Lel Inc 380 Oak St Copiague NY
Lieco Inc 130 Eileen Way Syosset LI NY
Ling Electronics Inc 9937 Jefferson Blvd Culver City Calif
Litton Industries Maryland Div 4900 Calvert Rd College Park Md
Litton Industries Electron Tube Div San Carlos Calif
Loral Electronics Corp 825 Bronx River Ave New York 72 NY
Luhrs & Co C H 297 Hudson St Hackensack NJ
Manson Laboratories Inc 375 Fairfield Ave Stamford Conn
Mark Products Co 5439 Fargo Ave Skokie Ill
Mayson Instruments Div Maxson Electronics Corp 475 Loth Ave NYC
MC Jones Electronics Co Inc 183 North Main St Bristol Conn
Mectron Co 166 Ridge Ave North Plainfield NJ
McMillan Industrial Corp Brownville Ave Ipswich Mass
Melabs Dept M7 3300 Hillview Ave Palo Alto Calif
Melpar Inc Special Products Dept 3200 Arlington Blvd Falls Church Va
Menlo Park Eng'g 711 Hamilton Ave Menlo Park Calif
Meridan Metalcraft Inc 8739 S Millergrove Dr Whittier Calif
Merrimac Research and Development 517 Lyons Ave Irvington NJ
Metavac Inc 45-68 162nd St Flushing 58 NY
Micacraft Products Inc 701 McCarter Hwy Newark 5 NJ
Mico Instrument Company 80 Trowbridge St Cambridge 38 Mass
Microflect Co 2300 S 25th St Salem Ore
Micro State Electronics Corp 152 Floral Ave Murray Hill NJ
Microtech Inc 1400 Milldale Rd Cheshire Conn
Microwave Associates Inc South Ave Burlington Mass
Microwave Development Labs 92 Broad St Babson Park Wellesley 57 Mass
Microwave Electronics Corp 4061 Transport St Palo Alto Calif
Microwave Tube Div Hughes Aircraft Co 11105 Anza Ave Los Angeles 45 Calif
Miller Associates PO Box 369 Lakeville Conn
Moran Instrument Corp 170 E Orange Grove Blvd Pasadena Calif
Nat'l Beryllia Corp 1st Ave Haskell NJ
Nichols Products Co 325 W Main St Moorestown NJ
Norden Div United Aircraft Corp 58 Commerce Rd Stamford Conn
Northeast Scientific Corp 30 Wetherbee St E Acton Mass
Panoramic Radio Products 520 S Fulton Ave Mt Vernon NY
Parker Seal Co Div Parker-Hannifin Corp 10567 Jefferson Blvd Culver City Calif
Peschel Electronics Inc Towners Rt 216 Paterson NJ
Philco Corp Tioga & C Sts Phila 24 Penna
Polarad Electronics Corp 43-20 34th St Long Island City 1 NY
PRD Electronics Inc 202 Tillary St Brooklyn 1 NY
Precision Tube Co Church Rd & Wissahickon Ave North Wales Penna
Premier Instrument Corp 33 New Broad St Port Chester NY
Prodelin Inc 305 Bergin Ave Kearny NJ
Production Research Corp Thornwood NY
Pye Canada Ltd 82 Northline Rd Toronto 16 Ont Canada
Radar Design Corp PO Box 38 Pickard Dr Syracuse 11 NY
Radar Measurements Corp 190 Duffy Ave Hicksville LI NY
Radiation Engineering Laboratory Main St Maynard Mass
Radio Eng'g Labs Inc 29-01 Borden Ave Long Island City 1 NY
Raytheon Co Microwave & Power Tube Div Foundry Ave Waltham 54 Mass
Reed & Reese Retron Corp 717 N Lake Ave Pasadena Calif
Reeves Instrument Corp East Gate Blvd Roosevelt Field Garden City NY
Remanco Inc 1805 Colorado Santa Monica Calif
Resdel Eng'g Corp 330 S Fair Oaks Ave Pasadena Calif
R F Products Div Amphenol-Borg Electronics Corp 33 E Franklin Danbury Conn
Rockbestos Wire & Cable Div Cerro de Pasco Corp 285 Nicoll St New Haven Conn
Sage Laboratories 3 Huron Drive East Natick Industrial Park Natick Mass
Sanders Assoc Inc 95 Canal St Washua NH
Saratoga Industries Congress & Ballston Aves Saratoga Springs NY
Sarkes Tarzian Inc East Hillside Dr Bloomington Ind
Saxton Products Inc 4320 Park Ave New York NY
Scientific Atlanta Inc 2162 Piedmont Rd NE Atlanta 9 Ga
S-F-D Laboratories 800 Rahway Ave Union NJ
Sierra Electronic Corp Div Philco Corp 3885 Bohannon Dr Menlo Park Calif
Sivers Lab Kristallvagen 18 Hagersten Sweden
Škitron Electronics & TV Corp 180 Varick St New York 14 NY
Specialty Automatic Machine Corp 80 Cambridge St Burlington Mass
Sperry Microwave Electronics Co PO Box 1828 Clearwater Fla
Stainless Inc North Wales Pa
Stewart Engineering Co 467 Bean Creek Rd Santa Cruz Calif
Stoddart Aircraft Radio Co 6644 Santa Monica Blvd Hollywood 38 Calif
Sunnyvale Development Center Sperry Gyroscope Co Div Sperry Rand Corp PO Box 697 Sunnyvale Calif
Sylvania Electric Products Inc Special Tube Operations 500 Evelyn Ave Mountain View Calif
Sylvania Electric Products Inc 100 Sylvan Rd Woburn Mass
Sylvania Electric Products Inc E 3rd St Williamsport Penna
Tamar Electronics Inc 2045 W Rosecrans Ave Gardena Calif
Technical Appliance Corp 1 Taco St PO Box 38 Sherburne NY
Technicraft Div Electronic Specialty Co Thomaston Conn
Telechrome Mfg Corp 28 Ranick Dr Amityville LI NY
Telecomputing Corp 915 N Citrus Ave Los Angeles Calif
Tele-Dynamics Div American Bosch Arma 5000 Parkside Ave Phila 31 Penna
Telerad Mfg Corp 1440 Broadway New York 18 NY
Telonic Engineering Corp 773 Broadway Laguna Beach Calif
Telonic Industries Inc 60 N 1st Ave Beech Grove Ind
Texas Instruments Inc/Apparatus Div 6000 Lemmon Ave Dallas 9 Texas
Torngren Co C W 236 Pearl St Somerville 45 Mass
Tower Construction Co 2700 Hawkeye Dr Sioux City 2 Iowa
Trak Microwave Corp Sub Trak Electronics Co 5006 N Coolidge Tampa Fla
Transco Products Inc 12210 Nebraska Ave Los Angeles 25 Calif
Transonic Inc 808 16th St Bakersfield Calif
TRG Inc 2 Aerial Way Syosett LI NY
Triex Tower Corp 2920 W Magnolia Blvd Burbank Calif
Tru-Connector Corp 416 Union St Lynn Mass
Turbo Machine Co Lansdale Penna
Universal Transistor Products Corp 36 Sylvester St Westbury LI NY
Varian Associates 611 Hansen Way Palo Alto Calif
Wacline Inc 35 S St Clair St Dayton 2 Ohio
Waltham Electronics Corp 751 Main St Waltham Mass
Waveguide Inc 1769 Placentia Costa Mesa Calif
Waveline Inc PO Box 718 W Caldwell NJ
Wave Particle 150 South 2nd Street Richmond Calif
Wayne Kerr Corp 1633 Race St Phila 3 Penna
Webcor Inc-Electronics Div 816 N Kedzie Chicago 51 Ill
Weinschel Eng'g 10503 Metropolitan Ave Kensington Md
Western Int'l Co 45 Vessey St New York 7 NY
Westinghouse Electric Co Div Air Arm Div PO Box 746 Baltimore Md
Westinghouse Electric Corp 3 Gateway Center PO Box 2278 Pittsburgh 30 Penna

Products & Manufacturers

Listing firms and the specific products they manufacture

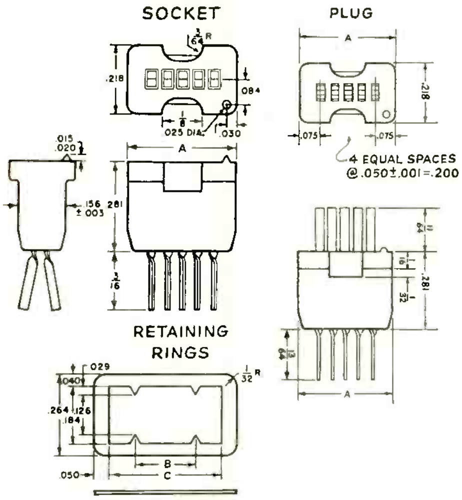
AMPLIFIERS

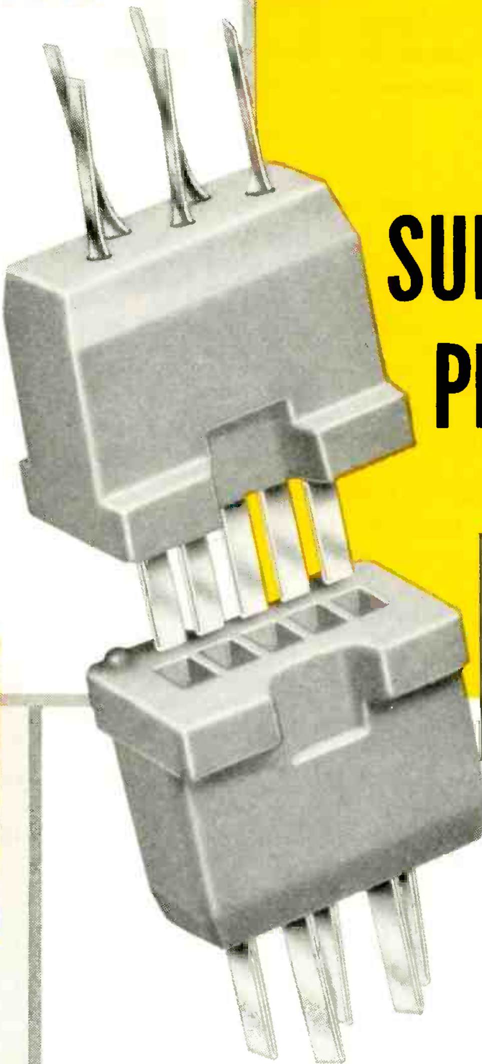
Amplifiers, bolometer	1
Amplifiers, klystron	2
Amplifiers, maser	3
Amplifiers, parametric	4
Amplifiers, radar	5
Amplifiers, TWT	6
Amplifiers, wideband	7

Adams-Russell Co.	7
Airborne Instruments Lab	4
Airtron A div of Litton Ind	4
Airtronics Inc	6-7
Alfred Electronics	6
American Machine & Foundry Co	5-7
American Microwave & TV Corp	2-7
Amperex Electronic Corp	5-6-7
Antlab Inc	1-3-9-13
Applied Technology Inc	1-6-7
Associated Electrical Industries	5
The Bendix Corp	5
Budelman Electronics Corp.	7
Canadian Marconi Co	2-5-6-7
Canoga Electronics Corp	2-4-5-7
Control Electronics Co Inc	4-5
Coopertronics Inc	2-6-7
Corbin Corp	2-4-7
DBM Research Corp	4-5-6-7
Demornay-Bonardi Corp	10-11
Dorne & Margolin Inc	4
Dynatronics Inc	7
Egan Laboratory	3
Eitel-McCullough Inc	2-6
Electronic Specialty Co	6
Elliott-Litton Limited	1-6
Farinon Electric	7
Frequency Engineering Laboratories	2-4-5-6-7
General Communication Company	5
General Dynamics/Electronics	4-5
General Electric Co	4
General Radio Co	7
GPL Division	5-7
Granger Assoc	2-6-7
Hallamore Electronics Div	7
Hallicrafters Co	4-6-7
Hazeltine Corp	4-5
Hughes Aircraft Co	4-7
ITT Federal Laboratories	2-3-4-5-6-7

(Continued on page 184)

NEW FROM CINCH®





Low-Cost
SUBMINIATURE PLUGS and SOCKETS
for low-current circuits

ACTUAL SIZE

for interconnecting low current circuits where miniaturization is important . . . electrical ratings conform to EIA standards

DIMENSIONS

No. of Contacts	A	B	C
3	.350 ± .003	.194	.360
4	.350 ± .003	.194	.360
5	.350 ± .003	.194	.360
6	.400 ± .003	.244	.410
7	.450 ± .003	.294	.460

NOMENCLATURE

PLUG	RECEPTACLE	RETAINING RINGS
3 contacts 204-92-03-047	131-13-12-095	441-00-11-082(105)
4 contacts 204-92-04-048	131-14-12-096	441-00-11-082(105)
5 contacts 204-92-05-049	131-15-12-097	441-00-11-082(105)
6 contacts 204-92-06-050	131-16-12-098	441-00-11-083(105)
7 contacts 204-92-07-046	131-17-12-099	441-00-11-084(105)

Molded of low-loss, mica filled phenolic insulation (type MFE per MIL-4-14E) with beryllium copper contacts, .00003 Min. Sel-rex gold plated. Available also, with glass-filled Diallyl Phthalate insulation (type SDG per MIL-M-18794).

May be swaged into metal chassis, cemented into Bakelite chassis, mounted with retaining ring or potted.

ELECTRICAL RATINGS

Maximum Rated Voltage AC-RMS
- Contact to contact........300 volts
- Contact to ground.........500 volts

Capacitance
- Measured from one contact to all other conducting parts...1.5 m.m.f. (Max.)

Insulation loss factor
- Maximum..........0.50 Dry

Insulation Resistance
- Measured from one contact to all other conducting parts.......50,000 Megohms (Min.)

Contact Resistance 0.50 Ohms (Max.)

Safe Operating Temperature
- Maximum....................80 C

Initial Insertion and Extraction Force
- 3 contact (Max.)............6 lbs.
- 4 contact (Max.)............7 lbs.
- 5 contact (Max.)............8 lbs.
- 6 contact (Max.)............9 lbs.
- 7 contact (Max.)............10 lbs.

Individual Contact Retension Force
- Minimum Gauge Weight....½ ounce

WRITE FOR FULL INFORMATION TODAY! Complete engineering data and detailed specifications on this line of low cost plugs and sockets is available. Yours for the asking, or phone NE 2-2000.

Cinch® ELECTRONIC COMPONENTS

CINCH MANUFACTURING COMPANY
1026 South Homan Avenue, Chicago 24, Illinois
Division of United-Carr Fastener Corporation, Boston, Massachusetts

ELECTRONIC DOT® ASSEMBLIES

Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; City of Industry, California, and St. Louis, Missouri

New Tech Data for Engineers

Microwave Antennas

Telerad, Div. of The Lionel Corp., Route 69-202, Flemington, N. J., is offering a 42-page catolog on microwave products covering coaxial transmission line equipment, antennas, waveguide, accessories, components and systems. Photographs, schematics, cut-aways, specs and engineering data are included.

Circle 316 on Inquiry Card

Directional Couplers

Microlab, 570 W. Mt. Pleasant Ave., Livingston, N. J., is offering a tech. catalog No. 10A to supplement Catalog No. 10 on coaxial components, featuring directional couplers and crystal mixers. Characteristic charts, outline drawings, photographs, and specs are included.

Circle 317 on Inquiry Card

Microwave Components

Airtron, a div. of Litton Industries, 200 E. Hanover Ave., Morris Plains, N. J., is offering tech. data on their microwave components, which includes isolators, ferrite devices, circulators, mechanical switches, dummy loads, cavity devices, antenna components, r-f assemblies, and flexible waveguide.

Circle 318 on Inquiry Card

DC Null Sensor

Verco Inc., 1430 130th N.E., Bellevue, Wash., is offering data on their solid state electronics for measuring and monitoring. Included is information on a hazardous current monitor, voltage limit detector, freq. source, overspeed indicator, battery voltage tester, ripple meter, load meter and linear ammeter.

Circle 319 on Inquiry Card

Delay Lines

Computer Devices Corp., 6 W. 18th St., Huntington Sta., N. Y., is offering a 4-page dissertation on delay lines entitled, "An Introduction to Delay Lines." This paper provides a simple, non-technical presentation about delay lines.

Circle 320 on Inquiry Card

Microwave Antennas

Canoga Electronics Corp., 15330 Oxnard St., Van Nuys, Calif., have tech. brochures on their AN/MPS-26 range instrumentation radar system rotary joints and their R10E-3A expanded metal radar reflectors, and tech. information on their S- and C-band cavity antennas, aerodynamic blade antennas, X-band lens antennas, in-line waveguide to coaxial adaptors, and rotary joints.

Circle 321 on Inquiry Card

Microwave Accessories

Antlab, Inc., 6330 Proprietors Rd., Worthington, Ohio, has a short form catalog including antenna pattern recorders, microwave receivers, boresight systems, antenna pattern integrators, radome mounts and fork-controlled oscillators. Schematics, photographs, outline drawings and specs are included.

Circle 322 on Inquiry Card

Strain Recording

Brush Instruments Div. of Clevite Corp., 37th & Perkins, Cleveland 14, Ohio, is offering a 20-page illustrated booklet entitled, "Strain Recording with Brush Direct Writing Recorders." Described are applications of strain gages and strain gage based transducers for measuring strain, tension, thrust, load, torque, etc. Photographs, circuit charts and diagrams are included.

Circle 323 on Inquiry Card

Power Supplies

Power Sources, Inc., Northwest Industrial Park, Burlington, Mass., is offering tech data on their modular transistor regulated power supplies, for laboratory and prototype work.

Circle 324 on Inquiry Card

Microwave Measurement

Wiltron Co., 717 Loma Verde Ave., Palo Alto, Calif., has an article on analysis and measurement of phase characteristics in microwave systems. This article contains phase information valuable to engineers doing work with microwave tubes, components, and semiconductors and in physical science research areas such as linear accelerators.

Circle 325 on Inquiry Card

Rotary Joint Design

Sage Laboratories, Inc., 3 Huron Dr., E. Natick Industrial Park, Natick, Mass., is offering 3 new tech. discussions entitled, "Microwave Crystal Diodes," "Noise Figure & Sensitivity of Mixers & Video Detectors" and "Rotary Joint Design." The discussions include outline drawings, schematics, diagrams, and characteristic charts.

Circle 326 on Inquiry Card

UHF Power Oscillator

Maxson Instruments Div., Maxson Electronics Corp., 475 Tenth Ave., New York 18, N. Y., is offering tech data on their uhf wide range power oscillator and power supply. Features are power at 40 w.; stability of a precision coaxial cavity and a range of 200 to 2500 mc, continuously variable in 2 bands.

Circle 327 on Inquiry Card

Power Conversion

Varo, Inc., 2201 Walnut St., Garland, Tex., is offering tech data on their frozen-diode power blocs. Schematics, photographs, explanations, specs and general information is included.

Circle 328 on Inquiry Card

Diodes

Microsemiconductor Corp., 11250 Playa Court, Culver City, Calif., is offering tech information on their fast recovery micro-diodes, ultra-fast recovery micro-diodes, general purpose diodes, and rectifiers. Some characteristics include recovery times at 1.5 nsec., power dissipation at 0.300 w. @ 25°C and average rectified current, up to 0.200 a. @ 25°C: 0.060 a. @ 150°C.

Circle 329 on Inquiry Card

UHF Bandpass Filters

Melpar, Inc., Special Products Div., Sub. of Westinghouse Air Brake Co., 3000 Arlington Blvd., Falls Church, Va., is offering tech data on their line of uhf bandpass filters featuring center freqs. of 400 to 1500 mc; bandwidths of 5 to 20% and signal rejection greater than 20 db at one bandwidth from filter center freq.

Circle 330 on Inquiry Card

Microwave Receiver

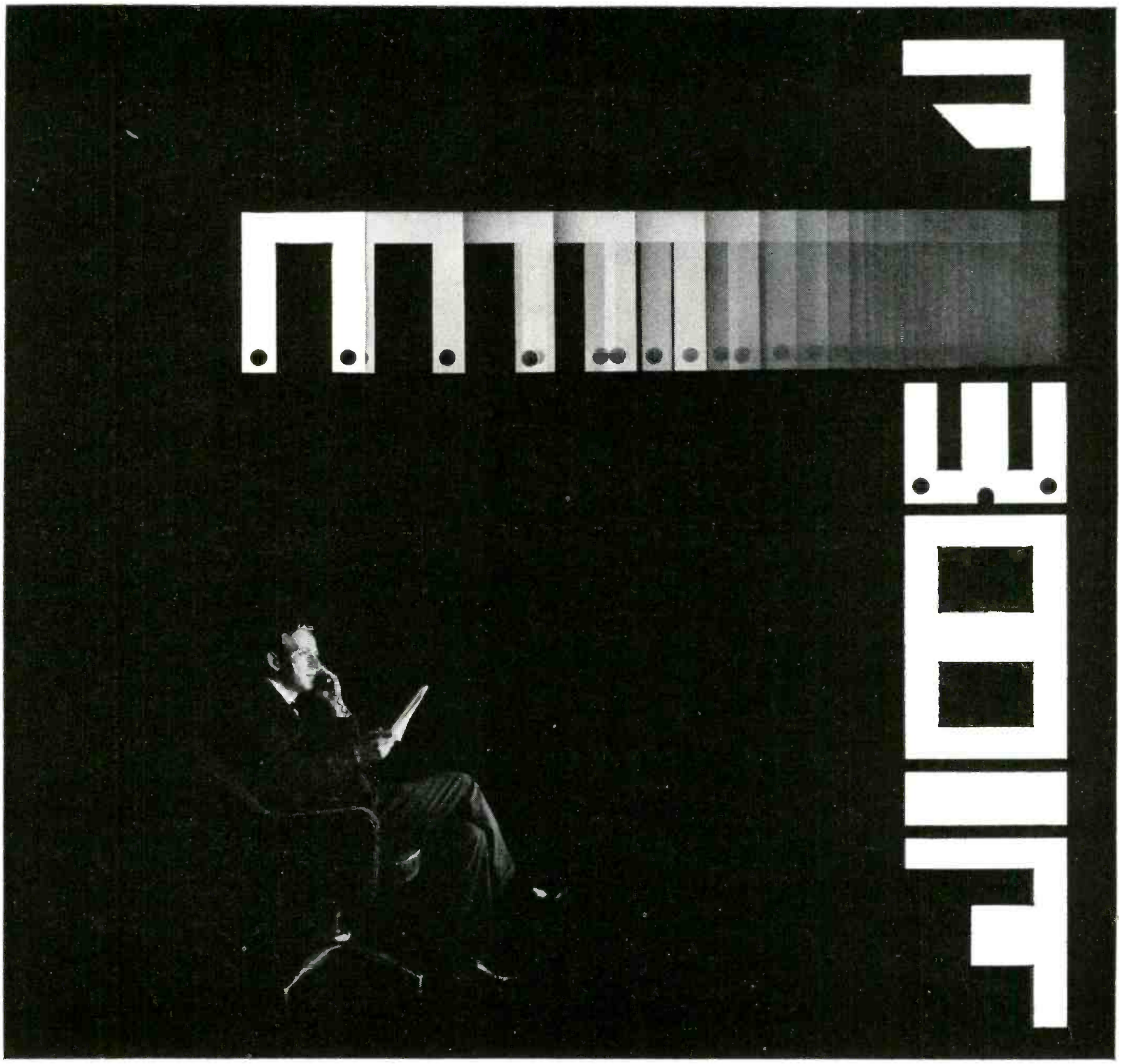
Sperry Microwave Electronics Co., Div. of Sperry Rand Corp., Clearwater, Fla., is offering tech. information on their Microline (TM) Model 61A1 parallel i-f substitution receiver system. This model is offered in 3 output freq. ranges: S-band, 2-4 GC; C-band, 4-8 GC; and X-band, 8-12.4 GC.

Circle 331 on Inquiry Card

Microwave Information Kit

Andrew Corp., P. O. Box 807, Chicago 42, Ill., is offering an antenna system information kit for microwave engineers. Included are catalogs on Heliax flexible air dielectric cable, microwave antennas and accessories, rigid coaxial transmission lines, hubloc antennas, microwave log periodic antennas covering 300 to 3000 mc, and a tech. bulletin entitled, "Performance Aspects of Dish Radomes" plus a parabolic antenna system computer and transmission line and waveguide selector. The parabolic antenna system computer is for calculating parabolic antenna radiation, characteristics, performance of passive repeaters, free space and tropospheric forward scatter, propagation attenuations and thermo noise and equivalent noise in.

Circle 332 on Inquiry Card



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Circle 360 on Inquiry Card

New Tech Data for Engineers

Microwave Components

Melabs, 3300 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif., is offering a condensed catalog and product summary No. 861 describing their line of microwave instrumentation and special products and microwave components. Included are electronically tuned signal generators, a crystal video receiver, electronically tuned superhet receiver, low noise TWT amplifiers, parametric amplifiers, masers, telemetry receivers, antennas, satellite r-f checkout systems, band separation filters, diode switches or modulators, and isolators.

Circle 333 on Inquiry Card

Delay Lines

Bel Fuse Inc., 198 Van Vorst St., Jersey City, N. J., has data available on Nanalines®, new nanosec. delay lines for use with high speed circuitry. Lines are available with time delays of 5 to 100 nsec; rise-time for a 100 nsec delay line is 9 nsec.

Circle 334 on Inquiry Card

Resistors

Mepco Inc., Morristown, N. J., is offering Engineering Catalog WC-3 on precision resistors which include Mil-R-93B wire-wound resistors, packaged networks and filters, high stability instrument wire-wound resistors, printed circuit w.-w. resistors, Mil-R-10509C epoxy-cased carbon-film resistors and resin-coated carbon-film resistors.

Circle 335 on Inquiry Card

Ferrite Components

Rantec Corp., Calabasas, Calif., is offering tech. data on their coaxial ferrite junction devices. Information is included on coaxial 4-port circulator, coaxial isolators, coaxial 3-port circulators, and coaxial switches, modulators and variable attenuators.

Circle 336 on Inquiry Card

Tuning Fork Oscillator

Fork Standards, Inc., 1915 N. Harlem Ave., Chicago 35, Ill., has tech data available on tuning fork oscillators featuring 2 series of transistorized models. Model C custom series for exact high precision requirements and Model E economy series for less rigorous use where low cost is a requirement.

Circle 337 on Inquiry Card

Microwave Tubes

American Elite, Inc., 48-50 34th St., Long Island City, N. Y., has a tech. manual available, including specs and curve sheets, on a line of Telefunken special purpose tubes such as microwave, cathode ray, gas-filled, photo, transmitting, and vacuum capacitors.

Circle 338 on Inquiry Card

Varicaps

Pacific Semiconductors, Inc., 12955 Chadron Ave., Hawthorne, Calif., has released tech. data on 10 new High-Q Varicap (voltage-variable capacitors). The line covers from 47 pf to 6.5 pf with Q values from 50 to 125 and working voltages from 25 to 100 v.

Circle 339 on Inquiry Card

Computing System

The Bendix Corp., Computer Div., 5630 Arbor Vitae St., Los Angeles 45, Calif., is offering a tech brochure illustrating the hardware, software and service features of the G-20 computing system. Included is information on support programs, program libraries, space programming on-site maintenance teams.

Circle 340 on Inquiry Card

Resolver Bridge

Electro Scientific Industries, 7524 S. Macadam Ave., Portland 19, Ore., is offering tech. data on their impedance, resistance, comparison, synchro and resolver bridges, transformer decade voltage dividers, resistance transfer standards, standard resistors & capacitors, and resistance decade voltage dividers.

Circle 341 on Inquiry Card

Wires & Cables

Rockbestos Wire & Cable Co., Div. of Cerro Corp., Nicoll and Canner Sts., New Haven 4, Conn., is offering tech data on their line of aerospace and electronic wire and cables. Included are airframe wires, hook-up wires, ground support cables, coaxial cables, and miniature high temp. wires.

Circle 342 on Inquiry Card

Frequency Meter

Measurements, A McGraw-Edison Div., Boonton, N. J., is offering tech. data on their standard frequency meter, Model 760. Specs include range, 25-475 MC; sensitivity, less than 5 mw on all ranges; crystal, oven temp. controlled type; system accuracy, ±100 cycles with crystal adjusted to WWV.

Circle 343 on Inquiry Card

Telemetry

Applied Electronics Corp. of New Jersey, Metuchen, N. J., has tech. data available on their solid state telemetry equipment. Featured is PCM digital telemetry systems, PDM multicoders completely transistorized, PAM, Model MAH-3 series of pulse amplitude modulation multicoders, solid state commutators, and dc amplifiers.

Circle 344 on Inquiry Card

Vacuum Tube Handbook

Raytheon Co., Industrial Components Div., 55 Chapel St., Newton 58, Mass., is offering a handbook with complete descriptions of 142 miniature vacuum electron tubes for industrial, military and communications applications. Tube characteristics, tube based diagrams and connections are included.

Circle 345 on Inquiry Card

Ferrite Load Isolators

Caswell Electronics Corp., 414 Queens Lane, San Jose 12, Calif., is offering Condensed Catalog C-5 on ferrite microwave components and sub-assemblies. Included is information on variable attenuators, ferrite modulators, slide screw tuners, adjustable isolators, reversible isolators and waveguide ferrite load isolators.

Circle 346 on Inquiry Card

Transistors

Fanon Transistor Corp., 439 Frelinghuysen Ave., Newark 12, N. J., has issued tech. data on their line of npn silicon diffused-junction mesa power transistors intended for high power industrial and military use. Features are collector currents up to 7.5 a.; collector voltages up to 100 v.; power levels up to 85 w. @ 25°C and 45 w. @ 100°C.

Circle 347 on Inquiry Card

Resistors

Corning Electronic Components, Corning Glass Works, Bradford, Pa., has tech. data on their metallic oxide resistors which meet performance requirements of Mil-R-10509. Available in ¼, ½, 1 and 2-w. sizes, the units are for high gain low signal amplifiers, high freq. circuits, test equipment, and circuits subject to instantaneous overloads.

Circle 348 on Inquiry Card

Microwave Components

Diamond Antenna & Microwave Corp., 35 River St., Winchester, Mass., is offering a catalog covering their line of antenna systems, rotary joints, microwave components, microwave test equipment, and microwave accessories. Specs, descriptions and photographs plus outline drawings are included. Also included is a section of custom components.

Circle 349 on Inquiry Card

Microwave Switch

Kearfott Div., General Precision, Inc., Little Falls, N. J., will send tech. data on their new line of radar test sets, isolators, filters, ultra high speed microwave switches, circulator-duplexer, ferrite amplitude modulator and variable attenuator X-band, and Delta coupler.

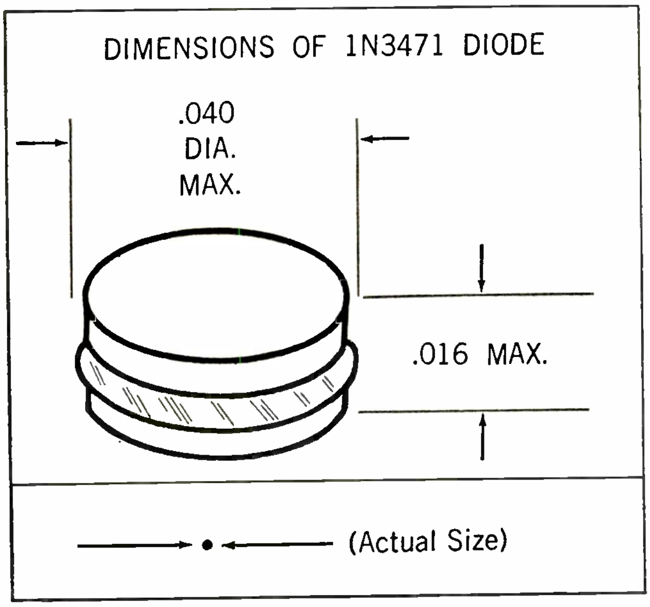
Circle 350 on Inquiry Card

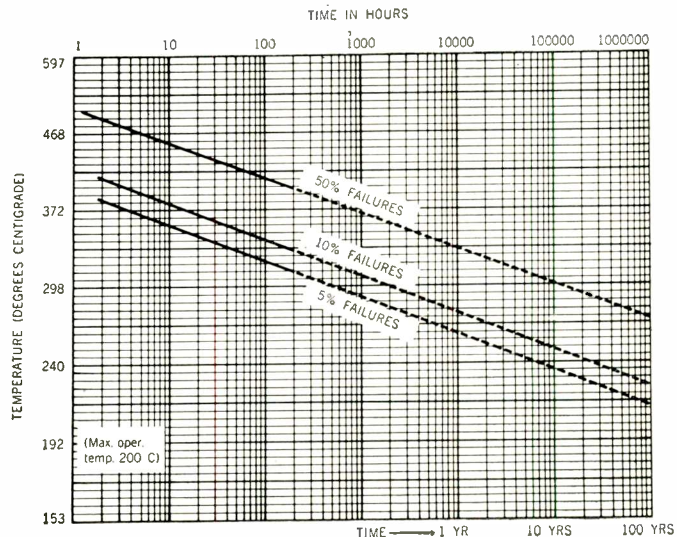
To Contractors and Subcontractors on U. S. Government Projects

THE 1N3471 "PINHEAD"

Western Electric offers this new Microminiature Switching Diode from Laureldale

The 1N3471 is a diffused silicon microminiature switching diode designed for high-speed operation. The size and construction of this pinhead diode suit it for high-density packaging. Controlled manufacturing conditions assure the circuit designer of uniform lot-to-lot diode characteristics with exceptional performance and reliability. (A leaded version of the 1N3471 diode is also available.)





STRESS-TIME RELIABILITY

High-temperature life tests are conducted for 1000 hours to assure (with 90% confidence) a failure rate at 250°C of less than 5% per 1000 hours.

MAXIMUM RATINGS

(Mounting Surface Temp. 100°C)

BV	40 Min.
Power dissipation	0.5 Watt
Tstg	—65°C to + 250°C
I_F	120 mAdc

SPECIFIED LIMITS FOR ELECTRICAL CHARACTERIZATION

trr ($I_F = I_R = 10$ mAdc)	2 nsec max.
V_f ($I_F = 10$ mAdc)	1 Volt dc
Is ($V_R = 20$ Vdc)	20 nAdc
C ($V_R = 0$; $f_o = 100$ kc)	3 pf
BV ($I_R = 5\ \mu$Adc)	40 Vdc

The 1N3471 microminiature switching diode can be purchased in quantity from Western Electric's Laureldale Plant. For technical information, price, and delivery, please address your request to: Sales Department, Room 105, Western Electric Company, Incorporated, Laureldale Plant, Laureldale, Pa. Telephone—Area Code 215—WAlker 9-9411.

LAURELDALE PLANT

MAKER OF ELECTRON PRODUCTS
FOR U. S. MILITARY AND SPACE APPLICATIONS

Western Electric

MANUFACTURING AND SUPPLY · BELL SYSTEM · UNIT OF THE BELL SYSTEM

Circle 69 on Inquiry Card

New Tech Data for Engineers

Silicon Transistors

Texas Instruments Incorporated, P. O. Box 5012, Dallas 22, Tex., is offering a 22-page brochure with complete specs on their germanium transistors, silicon transistors, diodes and rectifiers, solid tantalum capacitors, materials and sensors, resistors, and semiconductor networks. Complete specs are included.

Circle 298 on Inquiry Card

Microwave Test Equipment

California Technical Industries, Div. of Textron, Inc., 1421 Old County Rd., Belmont, Calif., is offering a 22-page catalog on microwave test equipment which features VSWR measuring systems, magnetron r-f supplies, variable polarization antennas and automatic radome beamship measuring system.

Circle 299 on Inquiry Card

Infrared Heating

Fostoria Corp., Dept. 109, 1200 N. Main St., Fostoria, Ohio, is offering tech data on radiant heat. Brochure describes Fostoria's equipment for use of electric infrared radiant heating processes and pictures some of the many and varied applications.

Circle 300 on Inquiry Card

Traveling Wave Tubes

Microwave Electronics Corp., 4061 Transport St., Palo Alto, Calif., is offering a tech data on their traveling wave tubes. Characteristic charts, complete electrical specs, and photographs are included on low noise tubes, medium power tubes, low power tubes, and Serrodyne and special purpose tubes.

Circle 301 on Inquiry Card

Microwave Insulators

Isolantite Mfg. Corp., Warren Ave., Stirling, N. J., is offering tech information on its line of silicone alloy materials for microwave electronic applications. Physical as well as electrical properties are contained in a full page, easy-to-read chart.

Circle 302 on Inquiry Card

Transistor Cooling

IERC Div., International Electronic Research Corp., 135 W. Magnolia Blvd., Burbank, Calif., is offering a 48-page Test Report 172A giving junction and case temps., power dissipation for power transistors in a variety of natural and forced air environments. Report evaluates an advanced dissipator design said to be twice as efficient as conventional fin-types of equal volume.

Circle 303 on Inquiry Card

Cooling Devices

Rotron Mfg. Co., Inc., Woodstock, N. Y., has a condensed catalog on their line of cooling devices. Also included is information on a determinator kit for determating correct vane size and sensitivity rating required for final equipment design.

Circle 304 on Inquiry Card

Atomic Instruments

Baird-Atomic, Inc., 33 University Rd., Cambridge 38, Mass., is offering their Atomic Instrument Catalog. Included are analytical scintillation systems, scalers, analyzers, rate and survey meters, amplifiers and power supplies.

Circle 305 on Inquiry Card

Microwave Components

Budd Stanley Co., Inc., 175 Eileen Way, Syosset, L. I., N. Y., is offering a 205-page catalog on their line of microwave test instruments and components. Some products listed include fixed waveguide attenuators, variable calibrated flap attenuators, precision multi-hole directional couplers, series Tees, standards gain horns, standard reflection waveguide terminations, shorting waveguide switches, E and H plane waveguide bends and coaxial slotted lines. Descriptions, photographs, outline drawings, electrical and mechanical specs and applicable military specs plus a section on basic principles of microwaves are included.

Circle 306 on Inquiry Card

U-Band Oscillators

Sperry Rand Corp., Sperry Electronic Tube Div., Section 101, Gainesville, Fla., is offering tech information on their 2-cavity U band oscillator family for parametric amplifier pumping and Doppler radar applications. One of the features is the constant output power versus beam voltage characteristic resulting in a flat top power output mode.

Circle 307 on Inquiry Card

Potentiometer

CTS Corp., Elkhart, Ind., has available tech. information on their new Series 720 compact step-driven potentiometer and switch unit. Photos, drawings and full tech. specs cover this unit which is for remote control applications.

Circle 308 on Inquiry Card

Filters

Erie Resistor Corp., Erie Electronics Div., 644 W. 12th St., Erie, Pa., is offering tech bulletin 512 covering 6 styles of high frequency low pass filters with minimum attenuation of 45 to 50 db. Capacitance of 1000 pf to 5000 pf and working voltage of 200 to 500 vdc.

Circle 309 on Inquiry Card

Coaxial Connectors

The Deutsch Co., Electronic Components Div., Municipal Airport, Banning, Calif., will send a 10-page catalog describing their line of subminiature coaxial connectors. Specs, performance characteristics, and detailed information on the techniques for assembling these all-crimp terminated r-f connectors are included.

Circle 310 on Inquiry Card

Potentiometers

Borg Equipment Div., Amphenol-Borg Electronics Corp., 120 S. Main St., Janesville, Wis., has available a wall chart which is a Borg Micropot® selector chart. Under precision Micropot potentiometers, single-turns, three-turns, and ten-turns are listed with housing diameter, operating temps, electrical and mechanical environmental servo mount and bushing mount specs. Under trimming Micropot potentiometers, 5 series are listed with specs.

Circle 311 on Inquiry Card

Breadboarding

Circuit Structures Lab., P.O. Box 36, Laguna Beach, Calif., will send data on their circuit builder which is designed for breadboarding and training; it eliminates soldering; gives quick circuit change; and is for vacuum tube or solid state circuits.

Circle 312 on Inquiry Card

Tubing

J. Bishop & Co., Platinum Works, Malvern, Pa., is offering Bulletin No. 13, 20 pages, which gives the sizes, specs, finishes, tolerances, chemistry and suitable uses for small dia. tubing line up to 1 in. O.D.

Circle 313 on Inquiry Card

Multiple Connectors

AMP Inc., Eisenhower Blvd., Harrisburg, Pa., has available tech. data describing their 3 separate lines of multiple connectors, Fastin-Faston®, AMPEEZ® and AMP-LOK®. Photographs, outline drawings and specs are included.

Circle 314 on Inquiry Card

Microwave Equipment

Radio Corp. of America, Industrial Electronic Products, Camden 2, N. J., is offering the following 3 pieces of tech literature: CW-20B Microwave describing 2000 MC microwave equipment which provides 120 channel capacity with max. economy; MM-600-6, microwave information on their 6000 MC 600 channel transcontinental microwave equipment; CT-42, transistorized tone multiplex describing their tone multiplex unit that provides telemetering, teletype, data and control channels for use with either microwave or wireline circuits.

Circle 315 on Inquiry Card

New Products . . . for the Electronic Industries

OSCILLATOR

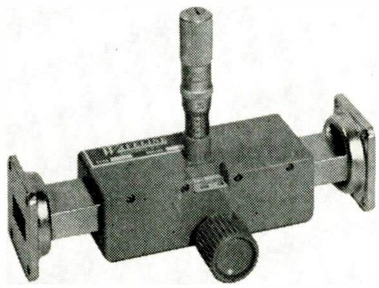
Portable, transistorized unit covers 5.5 CPS to 600 KC in 5 bands.

Model TO uses a special Wein Bridge circuit, printed circuit wiring and diode voltage regulation. High stability components are used in the freq. determining network to provide long time stability. This unit, with the Model TR Full Transistor Voltmeter, provides all the equipment necessary to check transmission lines, carrier equipment, sound systems and other types of field and laboratory work. Stewart Bros., Div. of Instrument Laboratories, 315 W. Walton Pl., Chicago 10, Ill.

Circle 189 on Inquiry Card

WAVEGUIDE TUNERS

Line of 6 slide screw units cover the range of 5.85 to 40.0 GC.



These slide screw tuners consist of a section of precision waveguide, slotted longitudinally in the center of one broad wall, and an accurately constructed carriage, which supports the probe assembly. Complete shielding of the waveguide slot is achieved at all times and vswr values of 20 to 1 or higher can be reduced to 1.02 without introducing appreciable insertion loss. Sufficient longitudinal travel is provided in each unit to assure any desired phase shift. Waveline Inc., Caldwell, N. J.

Circle 191 on Inquiry Card

MODULAR POWER SUPPLIES

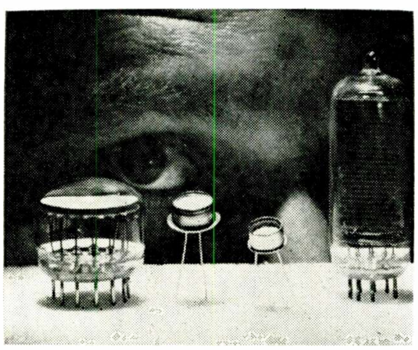
These units are for laboratory and prototype work.

They may be operated at full ratings without heat sink at up to 35°C amb. temp. The mounting base temp. is 65°C. These plug-in modular packages use all semiconductor circuits and operate isolated from the ac line, providing adjustable output. They are short circuit protected by current limiting and provide automatic recovery after short removel. Available, off the shelf, in a full line of specs. from 4.5-6.0 v. to 45-55 v. Power Sources, Inc., Northwest Industrial Park, Burlington, Mass.

Circle 193 on Inquiry Card

PHOTOCONDUCTIVE CELLS

Cadmium sulfide units feature low cost and wide variety of uses.

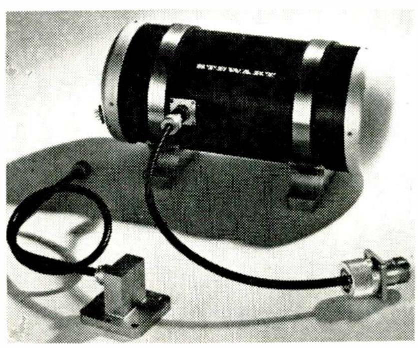


The "Compactron" type (Z-2946) and the conventional-tube envelope type (7427) are all glass, while the medium size cell (Z-2963) and the miniature (Z-2755-1) are of metal-to-glass construction. All the cells operate over a range of 1400Å units with the wavelength of max. response at 5500Å. Both the "Compactron" type and the 7427 have essentially the same ratings. Power dissipation is about 400 mw; max. current is 50 ma; and max. applied voltage is 350 v. General Electric Co., Receiving Tube Dept., Owensboro, Ky.

Circle 190 on Inquiry Card

MICROWAVE TUBES

First of a line of permanent-magnet focused BWOs from 1 to 40 GC.



These units of identical exterior appearance, feature integral permanent-magnet focusing, with the same reliable helix-type oscillator design used in the solenoid tubes to date. The new BWO's are both in the X-band, available either with type N or waveguide-adaptor termination at the end of RG55/U coax. cable. Significant advantages of these wide-band voltage tunable devices include low cathode current, more uniform r-f power over the band, and 2 control electrodes. Stewart Engineering Co., Santa Cruz, Calif.

Circle 192 on Inquiry Card

SPDT RELAY

Fast switching and stable contact resistance over long life.

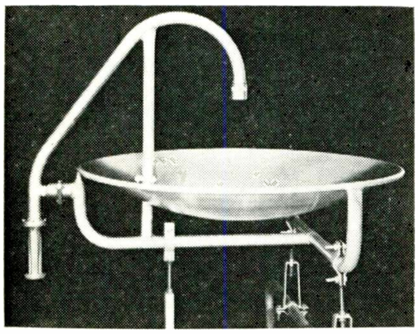
This SPDT reed type relay designated Magnereed Class 103 is hermetically sealed inside a glass capsule in an atmosphere of inert gas. The contacts are actuated magnetically by a coil around the glass switch capsule. The gold contacts are rated 10 w. resistive load; 1 a. or 250 vac max. Both operate time and release time are less than 1 msec., not including bounce time. Dimensions: coil, 2⅛ in. long, ½ in. dia.; overall including leads, 3½ in. long. Magnecraft Electric Co., 3350H West Grand Ave., Chicago 51, Ill.

Circle 194 on Inquiry Card

New Products . . . for the Electronic Industries

CIRCULAR WAVEGUIDE FEED

The 6 to 8 GC line supplied in 4, 6, 8, and 10 ft. parabolas.

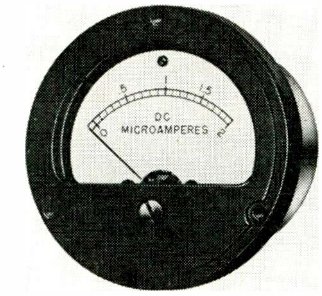


The circular waveguide feed, employing a rectangular to circular waveguide transition section 8 in. long, allows a man to adjust polarization a full 360° in the field simply by rotating the transition section. A dual polarized adapter is available for converting a single polarized feed simply by replacing the transition section. In addition to the 6 to 8 GC line, parabolas for 450, 900, 2000, and 12,500 MC bands are available. Mark Products Co., 5439 Fargo Ave., Skokie, Ill.

Circle 195 on Inquiry Card

MICROAMMETER

High sensitivity panel instruments can read 2 μa full scale.

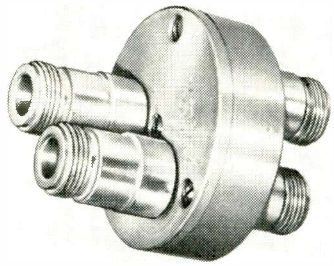


These rugged, transistorized meters are available in 1½, 2½ and 3½ in. sizes, and meet requirements of Mil-M-10304 specs. Designated Series HSR, these units will operate from any dc supply from 3 to 250 v. with a current drain of only 80 to 200 μa depending on supply voltage specified. Nominal input impedance is 95KΩ resistive. Accuracy is ±2% of full linear scale. Instrument Div., DeJur-Amsco Corp., Northern Blvd. at 45th St., Long Island City 1, N.Y.

Circle 197 on Inquiry Card

COAXIAL HYBRIDS

Operate over a 15% bandwidth, in freq. ranges from 950 to 6000 MC.



The new series, called the CJ type, consists of a coaxial line in the shape of a circle of 1½ wavelengths circumference with 4 branch arms. The CJ hybrids may be employed as balanced mixers, passive diplexers, power combiners, power dividers, variable phase shifters, balanced diplexers and as variable attenuators. They have a max. insertion loss of 0.2 db and an isolation of better than 25 db Microlab, 570 W. Mount Pleasant Ave., Livingston, N. J.

Circle 199 on Inquiry Card

PREAMPLIFIER

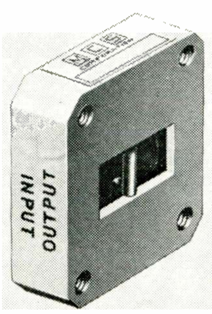
Amplifies signals of 1 pw, power gain of 333,000 from low level sources.

Miniature low-level "ACROSTAT" preamplifiers both-down units are in an epoxy potted, self-contained assembly operating from 115 vac ±10%. Model 104 is for use with thermocouples, strain gages, Hall devices and other low-level signal sources. Fully isolated input, output and power-in is provided. Repeatability at a specific environment is good. Equivalent input drift over environment is less than 50 μv. and less than 10 μv. with moderate environment. Acromag, Inc., 22515 Telegraph Rd., Southfield (Detroit), Mich.

Circle 196 on Inquiry Card

X-BAND FIXED ATTENUATOR

Unit provides 10 db of attenuation with only ½ in. insertion length.

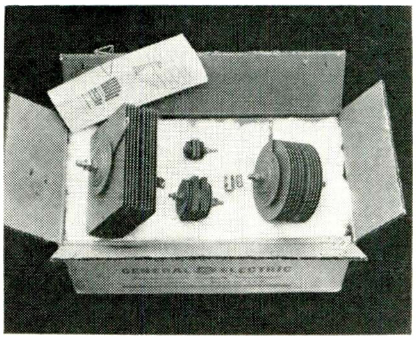


Designed to operate at 8.5-9.6 GC, this pad has an input vswr of 1.15 max. Illustrated, is model No. X218 which is used in X-band wave-guide systems or laboratory test set-ups. A molded-in attenuating element has high shock properties. Suitable for use over temp. range (−55° to +160°C) it also provides high dissipation properties, up to 1 w. CW. Other models at H-band (RG 51/U) and P-band (RG/91 U) are also available on request. Microwave Components & Systems Corp., 1001 S. Mountain Ave., Monrovia, Calif.

Circle 198 on Inquiry Card

SELENIUM DIODES

For controlling damaging voltage transients in semiconductor circuits.



Thyrector diodes are now in production and available in 6 cell sizes. The 6 cell sizes range from 9/32 and 15/32 in. dia. disks for mounting in tubes and 1 x 1, 2 x 2 and 5 x 6 in. plates and 4⅜ in. disks for stud mounting. The max. peak current in a single pulse of 4 msec. is 75 a. for the 9/32 in. cell; 3 a. for the 15/32 in. cell; 8 a. for the 1 x 1 cell; 30 a. for the 2 x 2 cell; 100 a. for the 4⅜ cell and 200 a. for the 5 x 6 cell. General Electric Co., Rectifier Components Dept., Carroll Ave. Plant, Lynchburg, Va.

Circle 200 on Inquiry Card

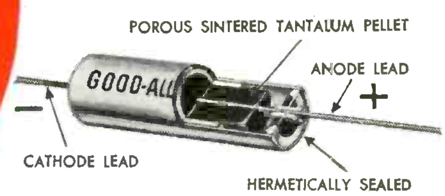
The NEW Quality line of SOLID

TANTALUM

Good-All CAPACITORS

"Built-in" Quality

of the Good-All type 901 solid tantalum capacitor is assured by precise control over the processing of all basic materials. This, combined with skilled handling of critical production phases gives the 901 its superior leakage characteristics, low dissipation factor and highly reliable service life. Extreme miniaturization combined with exacting design make the 901 an ideal choice for transistor, missile, communication, or similar circuitry.



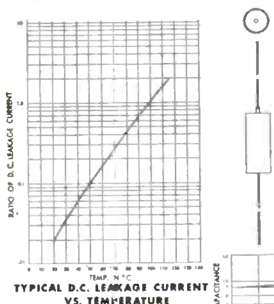
GOOD-ALL TYPE 901

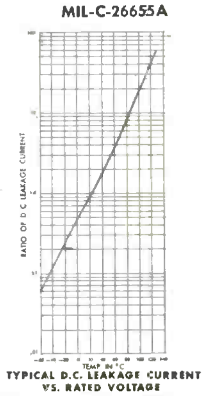
SOLID, POLARIZED TANTALUM CAPACITOR

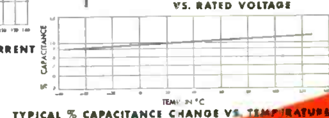
D.C. VOLTAGES 85°C—(For 125°C, derate to 67% rated voltage)

VOLTAGE	CAPACITANCE
35	.0047 mfd. to 47.0 mfd.
20	.0047 mfd. to 100.0 mfd.
15	.0047 mfd. to 150.0 mfd.
10	.0047 mfd. to 220.0 mfd.
6	.0047 mfd. to 330.0 mfd.

CASE SIZES— 4 subminiature sizes per MIL-C-26655A







SPECIFICATIONS

Temperature Range . . . −55°C to +85°C and to 125°C with proper derating.

Leakage Current . . . Complete listings in our technical brochure.

Tolerance . . . ±20% and ±10% (closer tolerances on special order).

Environmental Conditions . . . Will meet requirements of MIL-C-26655A.

Life Test . . . Will pass 2000 hours at +85°C and rated D.C. working voltage.

Dissipation Factor . . . 6% for case sizes A, B and C, and 10% for case size D—at 120 cps and +25°C.

Order NOW from Stock, at your Authorized Industrial Distributor

WRITE FOR TECHNICAL LITERATURE

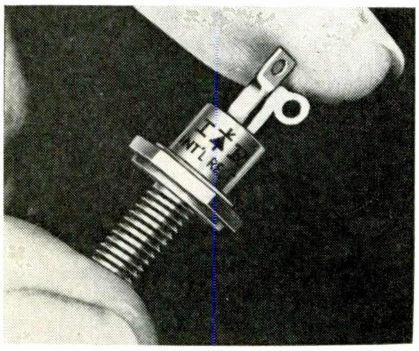
GOOD-ALL ELECTRIC MFG. CO. • OGALLALA, NEBRASKA

A SUBSIDIARY OF THOMPSON RAMO WOOLDRIDGE INC.

New Products . . . for the Electronic Industries

CONTROLLED RECTIFIERS

For computer, servo, inverter, and ac/dc control uses.

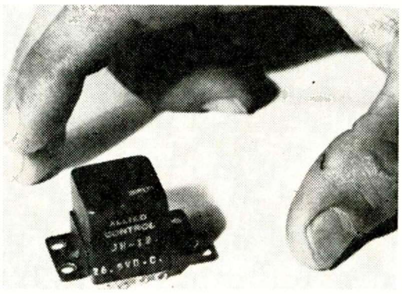


Designed specifically for low power switching and control applications, new series of silicon controlled rectifiers is capable of switching up to 3 a. of current over a piv range from 25 to 400 v. Designated types 3RC2 through 3RC40, they enable rapid firing with a min. of current (2.5 ma @ 125°C). All units feature hermetically sealed, all-welded construction, and measure approx. 1.18 in. overall length. International Rectifier Corp., 233 Kansas St., El Segundo, Calif.

Circle 273 on Inquiry Card

DC CRYSTAL CAN RELAY

Complete family of standardized crystal-can relays now available.

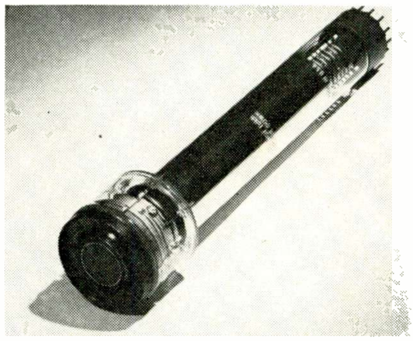


New 4PDT microminiature dc relay (JH-12) has contact rating of 2 a. non-inductive at 29 vdc, 115 vac; low-level contacts also available. Initial contact resistance: 0.05 max. Shock: 50g operational. Temp.: −65°C to +125°C. Insulation resistance (+25°C): 1000 megs min. Operate time, 10 msec max.; release time, 8 msec max. at nominal coil voltage and +25°C. Hermetically sealed, Max. weight is 1.4 oz. Allied Control Co., Inc., 2 East End Ave., New York 21, N. Y.

Circle 275 on Inquiry Card

IMAGE ORTHICONS

Fiber-optic face plates eliminate need for lenses.

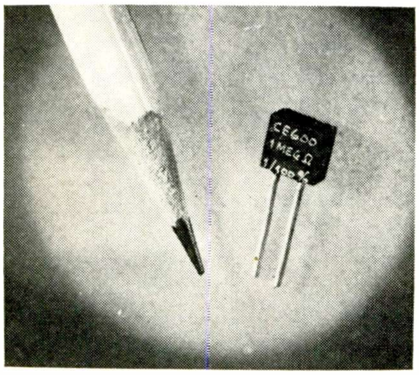


Use of the fiber-optic face plates in some applications has achieved light transmission gains of up to 50 times that possible with conventional optics. Fiber-optic face plates up to 3 in. in dia. are available. The new fiber-optic I-O's are designated ZL-7809 and ZL-7810. The ZL-7809 has an S-10 photo surface peaking at 4500Å. The ZL-7810 uses an S-20 photo surface peaking at 4250Å and has excellent red response. General Electric Co., Cathode Ray Tube Dept., Syracuse, N. Y.

Circle 277 on Inquiry Card

WIREWOUND RESISTORS

Hi-reliability wirewound unit is for microminiature use.

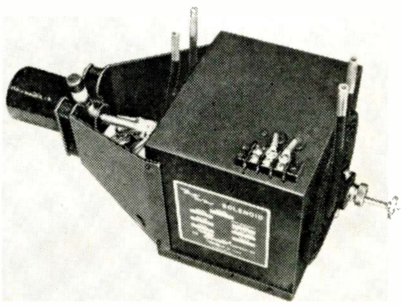


Designated "Aerohm," Type CE 600 measures 0.250 in. square x 0.125 in. thick and Type CE 601 measures 0.250 x 0.500 x 0.125 in. Specs: Max. voltage—150 vdc; Max. resistance—Type 600—1 meg.; Type 601—1.5 meg.; Tolerance—1% through 0.01%; Wattage rating—Type 600—0.125 w., −55° to +125°C; Type 601—0.250 w., −55° to +125°C; Temp. Coefficient —0 ±20ppm, −55°C to +125°C; Applicable Mil Specs—Mil-R-93 and Mil-R-9444; Operating Temps. from −65°c to +150°C. Cinema Plant, Hi-Q Div., Aerovox Corp., 1100 Chestnut St., Burbank, Calif.

Circle 274 on Inquiry Card

BWO'S

Types TWO-85A and TWO-87A operate at 70-85 GC *and 85-100* GC.

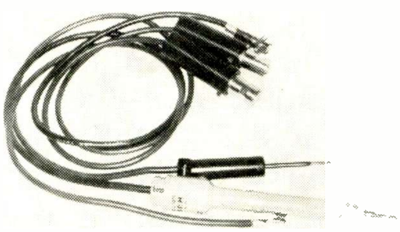


These tubes are similar in their construction and external dimensions to the TWO-66 and TWO-67, former types, and may be operated in the same focussing solenoids. They are entirely metal-ceramic in construction and hence can be rigorously processed during their exhaust cycle for max. performance and tube life. Additionally, these designs have incorporated ion pumps to maintain the necessary high vacuum within the tube throughout the life of the oscillator. The Bendix Corp., Red Bank Div., Electron Tube Products, Eatontown, N. J.

Circle 276 on Inquiry Card

WELDING TOOL

For small, pin-point welds entirely from one side of a work surface.

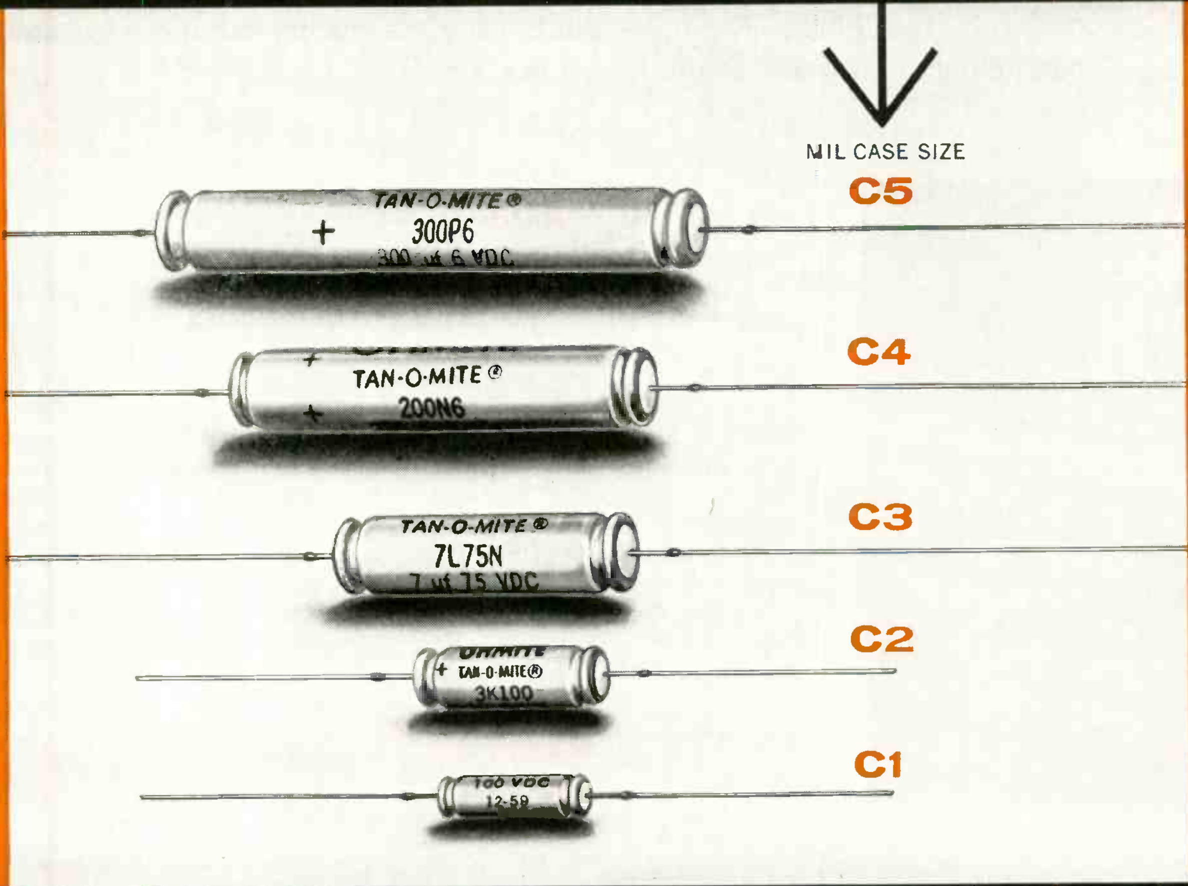


Pressure sensing pencil probe type welding handpiece, is designated the VTA-43. Sold as a set, it includes both a pressure sensing weld probe and a ground probe. The probe is adjustable to fire the weld energy at preset pressures ranging from ½ to 5 lbs., permitting welds of consistent quality on hard-to-get-at thin metal applications, such as those in high density electronic component assembly and strain gauge installation. The unit weighs 6 oz. without cables. Cable is supplied. Hughes Aircraft Co., Vacuum Tube Products Div., 2020 Short St., Oceanside, Calif.

Circle 278 on Inquiry Card

All 5 MIL Tantalum Foil Capacitor Sizes From OHMITE

MEET **MIL-C-3965B** —ALL VALUES IN STOCK



Plain and Etched

Whether you need *immediate delivery* from stock on prototypes, or production quantities of tantalum foil capacitors, Ohmite can handle your requirements.

Tan-O-Mite® Series TF foil capacitors now include all five MIL sizes in both plain and etched types, polar and nonpolar units, insulated and uninsulated cases—all in ratings to 150 VDC. Capacitance values for plain foil units range to 400 mfds; etched foil units, 580 mfds.

Write for Specification Bulletin 152G which lists 200 stock values, including all MIL values, and shows a *handy scale for conversion* between "equivalent series resistance," "power factor," and "dissipation factor."

OHMITE

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

OHMITE MANUFACTURING COMPANY
3662 Howard Street, Skokie, Illinois

Circle 71 on Inquiry Card

PHILCO SOLID-STATE for NEW MICROWAVE and

Whether you are designing new millimeter-wave systems, researching microwave computers, or breadboarding new equipment for established microwave applications, you will be interested in new solid-state components and concepts from Philco. The news shown on these pages, and more to come, can help you put more of the future in your designs.

In X- and K-Band Radars

Philco silicon mixer diodes, available in coaxial packages, offer premium features at *no* premium in price. Hermetically sealed packages and operating temperature ratings up to 150°C. are standard features of all types in the Philco 1N26 and 1N78 series.

Proof of outstanding uniformity—unit to unit—is the fact that any two Philco 1N263 diodes will serve as a matched pair. The 1N263, an X-Band mixer, is a low-noise performer. It can be operated fixed-tuned over the 8600 to 9600 mc-range. Its symmetrical construction allows easy polarity reversal in balanced mixers. IF impedance (Z_{if}) is 140 to 210 ohms; RF impedance (VSWR) is 1.3 max; overall noise figure (NF_{rec}) is 7.5 db max. Philco also provides models P-951 and P-952 narrow band and broad band crystal mounts to accommodate this X-Band mixer diode.

A new Philco concept for Doppler radar is the 1N1838—first germanium mixer diode specifically designed for ultra-low noise performance in radar receivers employing audio frequency IF amplifiers. It operates to 14 Kmc.

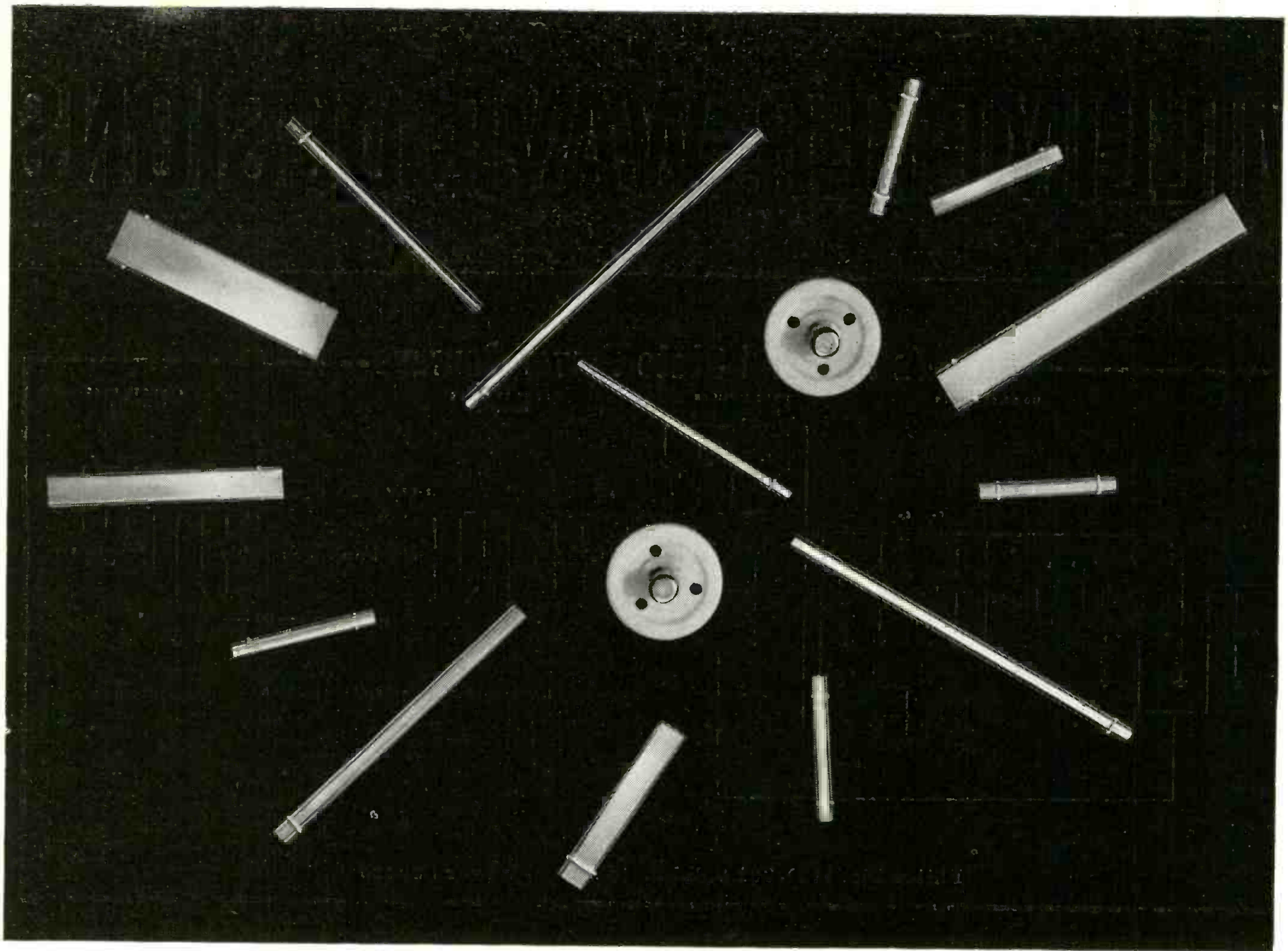
POPULAR MILITARY MIXER DIODES

Type	Applicable Military Spec.	Description
JAN 1N263	MIL-S-19500/191	Germanium X-Band Mixer
JAN 1N26	MIL-E-1/659B	Silicon K-Band Mixer
USA 1N26B	MIL-S-19500/128	Silicon K-Band Mixer
JAN 1N78	MIL-E-1/662A	Silicon K_U-Band Mixer
USA 1N78C	MIL-S-19500/130	Silicon K_U-Band Mixer


1N2792 GERMANIUM MILLIMETER WAVE MIXER DIODE

In Millimeter-Wave Designs

Philco pioneered, and now makes available, proved-in-use millimeter-wave germanium mixer diodes. Type 1N2792 offers a representative profile of this device category—operating at 70 Kmc. The 1N2792 is a reversible crystal designed for optimum low-noise performance in high resolution radar, EHF video detector applications and for long-range high altitude or space communications . . . atmospheric absorption prevents jamming from the ground. This crystal is of integrated waveguide construction with the diode mounted in a section of RG-98/U waveguide. It is hermetically sealed for resistance to moisture.



Superior Tube leads the way in cathode progress—offers you a complete line covering all needs.

THIS ADVERTISEMENT IS PRIVATE— FOR ELECTRON TUBE DESIGNERS ONLY

Which of these cathode developments means most to you? Which do you need right now? Which will you need tomorrow?

1. Low-power disc cathodes. Superior's miniature disc cathodes give a satisfactory electron beam with only ½ to ¾ the heater power required by standard sizes. New triangular hole ceramics reduce heater requirements still further, in addition to improving "warm-up" characteristics. Contact area is 60% less than with round hole ceramics.

2. Controlled E-dimension. In the manufacture of disc cathodes, Superior Tube controls E-dimension to within .0005 in. of specification. This permits interchangeability in tube assembly. Likewise it insures a uniformity of cut-off characteristic of tubes and permits use of a less costly fixed resistor in the grid circuit.

3. No seams. Superior's Weldrawn® process makes available no-seam cathodes in many materials not available in regular seamless form. Weldrawn cathodes are made by welding flat strip and cold drawing to desired dimensions.

4. All purpose cathode alloy. New Superior Tube Alloy X-3012 combines both the high emission capacity of active alloys and the long life normally associated with passive alloys. In addition, sublimation and interface impedance are reduced practically to zero. This alloy has twice the hot strength of ordinary nickel alloys and can take high current and overvoltage abuse. X-3012 is available in both sleeve and disc types.

5. Special alloys. The Cathaloy® series of cathode alloys was developed by Superior to provide a few alloys of broad application capable of meeting any cathode requirements, plus offering certain properties not available in other cathode alloys. These alloys greatly simplify cathode alloy selection. Their composition is carefully controlled, and electron tube tests of individual heats are made in Superior's Electronic Laboratory.

Do you have a copy of Superior's catalog No. 51 covering its complete line of cathodes and other electronic tubing products? Write Superior Tube Company, 2502 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

Johnson & Hoffman Mfg. Corp., Mineola, N.Y.
—an affiliated company making precision metal stampings and deep-drawn parts

Circle 73 on Inquiry Card

Circle 74 on Inquiry Card →

Factors to consider in silicon diode selection

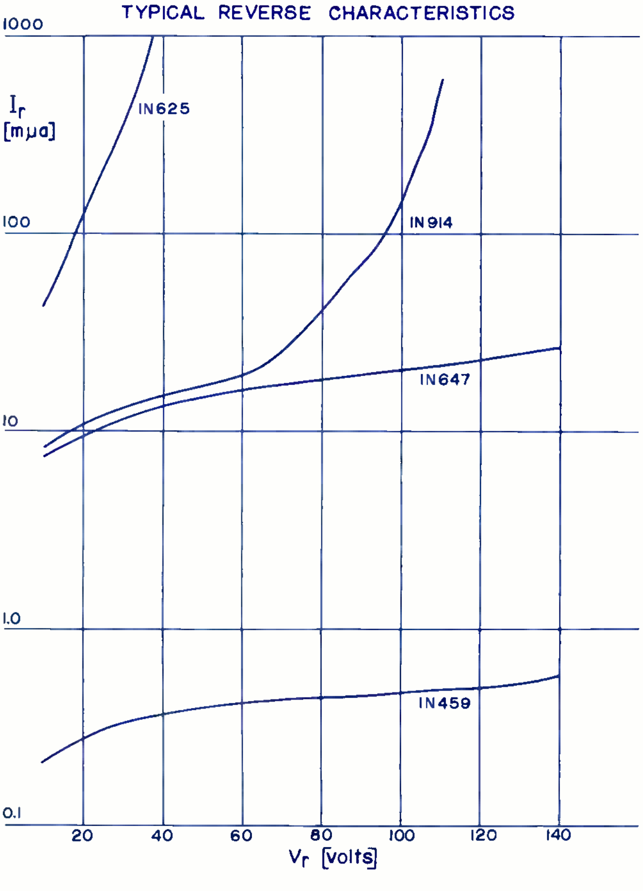
by DAVID E. HUMEZ

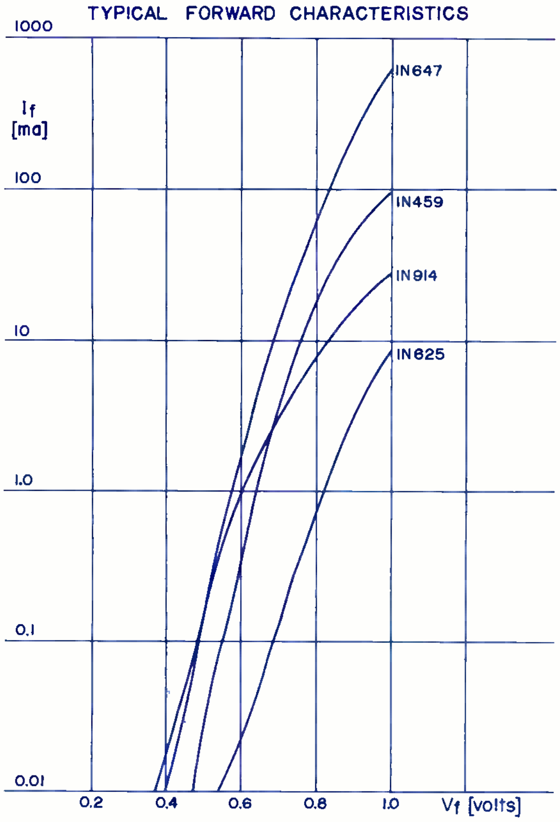
Technical Advisor to the Manager of Operations
Clevite Transistor, Waltham, Mass.

If your circuit does not require the superior forward conductivity characteristics of germanium diodes or if you require extremely low reverse currents or must operate at temperatures above 50°C, you will probably select a silicon diode.

Of the bewildering array of silicon diode types available some will almost certainly suit your circuit better than others. Current silicon diode types fall into four main categories with many sub-categories. The first category historically was the general purpose alloy junction silicon diode. These diodes are principally useful in those applications in which good high voltage characteristics, very low leakage currents, even at high temperatures, are necessary. They are available with comparatively high forward conduction and over a wide range of voltages up to several hundred volts.

The next category is that of computing application silicon diodes. These differ from the general purpose diodes in that the material from which they are made is doped or otherwise treated in such a way as to reduce its bulk lifetime. Reduction of the lifetime of the material makes possible much faster operation, that is, faster recovery when switched from the forward to the reverse condition. Such diodes have found wide application in military and commercial computing circuitry which is expected to operate at high temperatures. A price is paid, however, for higher speed since reducing the lifetime of the material results also in an increase of the reverse current and a decrease in the forward conduction.





The third and fourth groups are the most recent and employ a different method, namely, solid state diffusion for producing the PN junction. The third group, sometimes called rectifiers, are devices fabricated in either the same subminiature glass package familiar in other diode types or this glass package modified by the inclusion of a larger diameter stud at one electrode for improved heat conduction. They are large area devices compared to the diodes in categories one and two and are designed for conduction of as much as 400 milliamperes at a volt. Since their area is substantially larger, their capacitance is also larger though not as large as would be expected by the ratio of areas, since the method of producing the junction results in less capacitance per unit area than is characteristic of alloyed junctions.

SWITCHING SPEED —— REVERSE RECOVERY

Units switched by mercury wetted chopper from 15 ma forward current to 1.2 volts reverse in series with a 100 ohm load resistor. Recovery to 1 ma.

Unit	Time mμ sec.	Types
1N914	2.5	silicon mesa diode.
1N625	60.	high speed silicon alloy diode.
1N459	1500.	general purpose silicon diode.
1N647	8000.	silicon diffused rectifier.

The fourth and newest category is that of extremely small area devices made by the newer techniques of the mesa or planar constructions. These types are also manufactured by a diffusion process. They are designed primarily for applications in which the very fastest switching speeds are required. For this additional speed, compared to conventional computing alloyed junction types, a further price must also be paid. Because they are tiny, they are also less rugged. Because their area is smaller, both the resistance of the connecting wires and the spreading resistance are larger. Consequently, these devices as a group are characterized by somewhat poorer forward conduction than is true of the larger area computing diodes.

Ask for Silicon Diode Bulletins
CLEVITE TRANSISTOR
Waltham, Massachusetts

ELECTRONIC INDUSTRIES'

1962 Summary of

MICROWAVE ELECTRON DEVICES

Listing complete technical specifications on the more than 1,500 commercially available microwaves electron tubes—both foreign and domestic.

- *Magnetrons*
- *Planar Triodes & Tetrodes*
- *Klystrons*
- *Backward Wave Oscillators*
- *Traveling Wave Tubes*
- *Parametric Amplifiers*

MAGNETRONS

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V:A	Anode V:A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L.I., N.Y.							
5J26	osc,.001	1.22–1.35	23.5,2.2	28k,46		1	600kw
7090	osc,cw	2.425–2.475	5.3,3.2	1.6k,.2	5		200w
7091	osc,cw	2.425–2.475	5,32	4.5k,.75	4		2kw
7292	osc,cw	2.425–2.475	5,32	4.5k,.75	4		2kw
55125	osc,cw	2.425–2.475	5.5,66	6.5k,1.4			5kw
5586	osc,.p	2.7–2.9	16,3	32k,70	15	1	800kw
5657	osc,.0005	2.9–3.1	16,3	32.5k,70	15	1	800kw
6589	osc,.0005	3.35–3.5	16,3	30k,50	10	1	500kw
4J59	osc,.001	6.275–6.375	12.6,3.5	19k,30	15	1	210kw
4J58	osc,.001	6.375–6.475	12.6,3.5	19k,30	15	1	210kw
4J57	osc,.001	6.475–6.575	12.6,3.5	19k,30	15	1	210kw
2J51A	osc,.001	8.5–9.6	6.3,1	14k,14	18	3.4	60kw
4J78	osc,.001	9.003–9.168	13.7,3.5	23k,27.5	15	1	225kw
55032	osc,.001	9.003–9.168	13.7,3.5	23k,27.5	17.5	1	225kw
55031	osc,.001	9.168–9.345	13.7,3.5	23k,27.5	17.5	1	225kw
JP97A	osc,.001	9.21–9.27	6.3,.6	5.5k,4.5	15	1	7kw
7028	osc,.0002	9.345–9.475	6.3,.5	3.5k,2.5	14	.1	3kw
2J42	osc,.001	9.345–9.405	6.3,.6	5.5k,4.5	15	1	7kw
JP97D	osc,.0001	9.345–9.405	6.3,.6	5.5k,5.5	15	.1	8kw
JP915	osc,.001	9.345–9.405	6.3,.6	8k,6.5	18	2	19.5kw
725A	osc,.001	9.345–9.405	6.3,1	12k,12	15	1	50kw
6972	osc,.0002	9.345–9.405	10,2.8	15k,15	15	.1	75kw
4J52A	osc,.0001	9.375+.025	12.6,2.2	15k,15	15	5	80kw
4J50	osc,.001	9.345–9.405	13.7,3.5	23k,27.5	15	1	225kw
55030	osc,.001	9.345–9.405	13.7,3.5	23k,27.5	17.5	1	225kw
55029	osc,.001	9.405–9.505	13.7,3.5	23k,27.5	17.5	1	225kw
7093	osc,.0001	34.512–35.208	5,4	15k,15	40	.02	30kw
55008	osc,.0001	34.512–35.208	5,3.9	16k,17	40	.02	60kw
ASSOCIATED ELECTRICAL INDUSTRIES, LTD., Carlholme Rd., Lincoln, England							
BM1001	tun osc	2.994–3.002	8.5,10	46k,110	7	2	2megw
BM6787	osc,cw	.9–1	10.5,52	4k,.9			2.5kw
CV2320	osc,plsd	2.998	8.5,10	46k,110		2	2megw
CV2168–70	osc,plsd	S-band	8.5,10	48k,90		2	2megw
CV2319	osc,plsd	2.98–3020	8.5,10	38k,70		5	1.25megw
CV2117 to CV2123	osc,plsd	2.75–2.855	8.5,10	38k,70		2	1.2megw
CV120C,B,A	osc,plsd	2.748–2.858	6,7.7	27k,40		1	400kw
CV1495 to CV1500	osc,plsd	3–3.12	6,1.5	24.5k,22.5		.5	300kw
BM4119	osc,plsd	9.31–9.43	6.3,.9	21k,25		.1	140kw
CV2333 to CV2337	osc,plsd	9.505–9.695	6.3,.9	13.5k,12		.5	50kw
BM4073	osc,plsd	9.42–9.5	6.3,.9	14k		.25	40kw

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
ASSOCIATED ELECTRICAL INDUSTRIES, LTD.–*(Continued)*							
CV2313	osc,plsd	9.44–9.51	6.3,.9	16k,12		.5	50kw
CV5167	osc,plsd	9.04–9.12	6.3,.9	17k,11		.5	60kw
CV2167	osc,plsd	9.04–9.12	6.3,.9	14k,6		.5	30kw
BOMAC LABORATORIES, INC., Salem Road, Beverly, Mass.							
BL212	tun	5.4–5.9					100w
BL250	tun	5.4–5.9					150w
BL243	tun	5.4–5.9					200w
BL242	tun	5.4–5.9					400w
BLM008	tun	5.4–5.9					400w
BLM022	tun	5.4–5.9					500w
BLM026	tun	5.4–5.9					500w
BLM020	tun	5.4–5.9					700w
BL245	tun	5.4–5.9					900w
BL230	tun	5.4–5.9					1000w
BLM003	tun	9–9.5					150w
BLM014	tun	8.5–9					150w
BLM015	tun	9–9.5					350w
BLM024	tun	9.3–9.5					100w
BL233	fix	9.375 ±030					800w
BLM012	tun	8.9–9.4					1kw
BLM046	tun	8.9–9.4					1kw
5780	tun	8.5–9.6					250kw
BL216	fix	15.9–16.1					100kw
BLM027	tun	16–16.4					500w
6551	fix	23.8–24.27					40kw
BLM006	fix	23.8–24.27					40kw
BL235	fix	51–54					10kw
BL236	fix	54–57					10kw
BL237	fix	57–60					10kw
BL246	fix	68–71.5					8kw
BL221	fix	69–70					10kw
BRITISH INDUSTRIES CORP., 80 Shore Road, Port Washington, N.Y.							
CV76	.001	2.95	5,2.5	27k,35		2	450kw
CV160	.001	3	6,1.25	22.5k,22.5	7	1	200kw
CV192	.0008	3.288	6,1.25	21.5k,23		1	225w
CV214	.0005	9.65–9.7	3,2.5	15.5k,10	13	1	45kw
CV1475	.001	3.23–3.38	5,2.6	26k,40		0.5	450kw
CV1476	.001	3.23–3.38	5,2.6	26k,40		0.5	450kw
CV1477	.001	3.23–3.38	5,2.6	26k,40		0.5	450kw
CV1478	.001	3.23–3.38	5,2.6	26k,40		0.5	450kw
CV1479	.001	2.95–3.06	5,2.5	27k,35		2	450kw
CV1480	.001	2.95–3.06	5,2.6	27k,35		2	450kw

A statement about the Zenith electron-beam parametric amplifier–

. . . A New component in Radar, Telemetry, Satellite- and Deep-Space-Probe Tracking and Ranging, Radio-Astronomy, Radio-Navigation, Phase- and Frequency-Modulation Communications Systems.

In every new development, there comes a time for a review of progress and a look into the future. That time has come for the electron-beam parametric amplifier—the Zenith "EBPA." As a low-noise amplifier, its noise performance is in the 1 db range, with gain up to 45 db. Its utility and value have been provided in field tests of many systems.

THIS IS WHAT THE EBPA DOES, how it has proved itself, and what we believe it can do—

CAPSULE DESCRIPTION OF OPERATION

The EBPA system consists of a quadrupole-amplifier tube operating in a magnetic field, an RF pump generator, and a power supply. Within the tube, the signal is coupled onto an electron beam and amplified by the action of the quadrupole structure, using energy from the RF pump generator. The power supply furnishes voltages for the tube electrodes, solenoid, and RF pump generator.

PERFORMANCE CHARACTERISTICS

Noise Figures Obtainable: From 0.6 to 1.5 db, as measured with broadband noise source. No cryogenic apparatus is required. Single-channel noise figure depends on antenna and application—typically, 2.5 db. Mixer noise is negligible because of high gain.
Range of Center Frequencies: 350 to 1800 Mc (tubes of higher frequency are in development).
Phase Stability: Better than 1°.
Amplitude Stability: ±0.05 db has been measured.
Gain: Usually operated at 25 db; gain up to 45 db has been obtained.
Bandwidth: Up to 10 per cent of operating frequency.

OPERATING FEATURES

The EBPA not only provides low-noise performance, but also offers characteristics unattainable with other low-noise systems, such as:

- Unconditional stability with respect to input and output terminations without the use of a circulator.
- High gain, with complete freedom from regenerative effects.
- Relatively large bandwidth independent of gain; no tuning required.
- Freedom from burnout; insensitivity to overload—several watts average, several hundred watts peak power.
- Fast recovery time (30 nanoseconds).

SYSTEM DESIGN CONSIDERATIONS

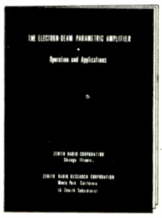
System Protection. The EBPA tube not only withstands large amounts of incident overload power but also reflects most of it. In radars, this characteristic means that TR tubes can be eliminated. In addition, the EBPA protects mixer crystals from "spikes," and eliminates need for harmonic filters and shutters; also, down time and maintenance are reduced.
Ease of Installation. EBPA systems have been installed in minutes and have operated immediately. Once installed, they are very stable and operate for long periods without adjustment.
Reliability. Life expectancy of the EBPA tube is of the order of 10,000 hours.
Adaptability to Systems. The EBPA is normally installed as a simple insertion unit in the system front end and does not entail radical alteration of existing designs.

APPLICATIONS

Radar: Search Type. In tests conducted on eight such radars, MDS improvements of 4 to 10 db were attained.
Radar: Phased-Arrays. The unusual phase and amplitude stability of the EBPA makes it a natural candidate for application as a preamplifier in phased-arrays. Power supply and RF pump are common to all units in such an installation to insure maximum uniformity. An experimental installation of this kind, involving 16 EBPA units, was recently delivered. (Data on this installation will be available soon.)
Tracking System. A set of three EBPA units has been completed for use in a tracking system. A common power supply and common RF pump were provided. Maximum noise figure of the equipment as shipped is 1.2 db. Lab tests indicate the equipment will meet the differential phase stability requirements for monopulse applications. (Data on this installation will be available soon.)
Radio-Astronomy. The EBPA has found its way into a number of big dishes used in radio-astronomy. It is usually installed as close to the feed as possible to cut transmission losses. It has been used for hydrogen-line work at 1420 Mc, and to amplify radar returns from the planet Venus at approximately 400 Mc. The high phase stability and large bandwidth have proved particularly useful in interferometer applications.
Radio-Navigation System. When installed in a Tacan ground station receiver, the EBPA improved MDS by 4.5 db.
Radio Direction-Finder. When installed in a Rawin set, the EBPA improved MDS by 15.0 db.
P-M and F-M Systems. In phase-lock receiving systems, it is feasible to use synchronous pumping with a degenerate EBPA, resulting in an effective noise figure of about 1 db. Applications are space-probe tracking, scatter communication, and in general, all systems using only phase or frequency modulation.

COMING SOON

- EBPA tubes for operation at C-band.
- Tunable EBPA tubes: single-knob tuning will cover range of over 100 Mc.
- A metal-ceramic tube for operation from 400 Mc to about 1500 Mc; features are external tuning, lower cost, and greater resistance to adverse environment.
- More compact power supply.
- Non-degenerate EBPA tubes.



If you wish more information, send for booklet **The Electron-Beam Parametric Amplifier, Operation and Applications.** Please address requests and any questions or comments to the Special Products Division, Dept. E-11, Zenith Radio Corporation; 6001 W. Dickens Ave.; Chicago 39, Illinois.

Zenith Radio Corporation
Wincharger Corporation
Central Electronics, Incorporated
Zenith Radio Research Corporation
The Rauland Corporation

ZENITH
Creative research and development in space age electronics

MAGNETRONS – *(Continued)*

BRITISH INDUSTRIES CORP. – *(Continued)*

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
CV1481	.001	2.95–3.06	5,2.6	27k,35		2	450kw
CV1482	.001	2.95–3.06	5,2.6	27k,35		2	450kw
CV1495	.001	3–3.12	6,1.25	21.5k,22.5	7	1	200kw
CV1496	.001	3–3.12	6,1.25	21.5k,22.5	7	1	200kw
CV1497	.001	3–3.12	6,1.25	21.5k,22.5	7	1	200kw
CV1498	.001	3–3.12	6,1.25	21.5k,22.5	7	1	200kw
CV1499	.001	3–3.12	6,1.25	21.5k,22.5	7	1	200kw
CV1500	.001	3–3.12	6,1.25	21.5k,22.5	7	1	200kw
MAG2*	.00025	9.35–9.5	3,2.5	1.5k,10	15	0.25	45kw
MAG3*	pkgd, .0001	9.345–9.405	6.3,0.55	6k,7	15	0.1	14kw
MAG4	.001	9.345–9.405	6.3,0.55	8k,6	15	1	17.5kw
MAG5	.001	9.36–9.45	3,2.3	17k,12	15	1	60kw
MAG7	pkg, .001	9.2–10	2,10	16k,15	15	1	80kw
MAG8	.004	9.2–9.6	6.3,0.2	0.95k,.025		2	800mw
MAG9	.001	9.335–9.485	3,2.5	13k,11	13	1	50kw
MAG10	.0005	9.74–9.89	6.3,1.3	14.5k,10	13	1	50kw
CV214	.0005	9.65–9.7	3,2.5	15.5k,10	15	1	47kw
CV370	pkgd, .001	9.21–9.27	6.3,0.55	5.7k,4.5	15	1	7.7kw
CV2111	.0005	9.59–9.89	6.3,1.3	14.5k,10	15	1	50kw
CV3982	.001	9.36–9.46	2,3.8	11.5k,12	15	1	45kw
CV5031*	.001	9.003–9.168	3,3.5	13.5k,12	12	1	50kw
CV5117	.0006	3.288–3.312	6.1.25	22k,24	7	0.5	180kw
2J51A		8.5–9.6	6.3,1	14k,14	15	1	50kw

**Available to Mil. Specs.*

CANADIAN MARCONI CO. 2442 Trenton Ave., Montreal 16, Canada

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
7138	osc, .0025	9.05–9.55	6.3,.51	7.8k,8	15	2.5	18kw
7139	osc, .0025	9.05–9.55	6.3,.51	7.8k,8	15	2.5	18kw
7140	osc,.0025	9.05–9.55	6.3,.51	7.8k,8	15	2.5	18kw
7141	osc,.0025	9.05–9.55	6.3,.51	7.8k,8	15	2.5	18kw
7142	osc,.0025	9.05–9.55	6.3,.51	7.8k,8	15	2.5	18kw
7143	osc,.0025	9.05–9.55	6.3,.51	7.8k,8	15	2.5	18kw
7182	osc,.0015	2.75–2.86	12,14	33k,185	5	6	2.5megw
2J42	osc,.0025	9.345–9.405	6.3,.51	6k,5.5	15	2.5	7kw
2J42A	osc,.0025	9.345–9.405	6.3	8k,7.5	15	2.5	18kw
4J50	osc,.002	9.345–9.405		23k,3.75	15	2.7	225kw
4J50A	osc,.002	9.345–9.405		23k,3.75	15	2.7	225kw
5J26	osc,.0025	1.22–1.35	23.5,2.2	34k,55	5	6	400kw
5586	tun	2.7–2.9	16,3.1	30k	15	2.5	800kw
5657	tun	2.9–3.1	16,3.1	30k	15	2.5	800kw
6027	osc,.0025	9.345–9.405	6.3	8k,8	15	2.5	18kw
6249A	osc,.0013	8.5–9.6	10	29k	15	2.8	200kw
6249B	osc,.0013	8.5–9.6	10	29k	15	2.8	200kw
6027H	osc,.0025	9.345–9.405	6.3,.5	8k,8	15	2.5	20kw
6764	osc,.0025	9–9.1	6.3,.5	7.6k,8	18	2.5	20kw
6765	osc,.0025	9.1–9.2	6.3,.5	7.6k,8	18	2.5	20kw
6766	osc,.0025	9.2–9.3	6.3,.5	7.6k,8	18	2.5	20kw
6767	osc,.0025	9.3–9.4	6.3,.5	7.6k,8	18	2.5	20kw
6768	osc,.0025	9.4–9.5	6.3,.5	7.6k,8	18	2.5	20kw
6769	osc,.0025	9.5–9.6	6.3,.5	7.6k,8	18	2.5	20kw

COMPAGNIE FRANCAISE THOMSON-HOUSTON, 6, Rue Mario-Nikis, Paris

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
TH1249	osc,.001	9.05–9.15	6.3,.8	15k,15		1	40kw
TH1249A	osc,.001	9.15–9.25	6.3,.7	15k,15		1	40kw
TH1249B	osc,.001	9.05–9.25	6.3,.8	15k,15		1	36kw
TH1250	osc,.001	8.75–8.9	6.3,.8	15k,15		1	40kw
TH1250A	osc,.001	8.85–8.95	6.3,.7	15k,15		1	40kw
TH1250B	osc,.001	8.8–9	6.3,.8	15k,15		1	36kw
TH4J50A	osc,.002	9.345–9.405	13.75,3.4	23k,30		1	225kw
TH4J52A	osc,.002	9.345–9.405	12.6,2.1	16k,30		1	80kw
THF1025	osc,.002	8.5–9.6	12.6,2.1	17k,20		1	70kw
TH1725A	osc,.001	9.345–9.405	6.3,.8	15k,15		1	40kw
TH1725B	osc,.001	9.275–9.475	6.3,.8	15k,15		1	36kw
TH1725C	osc,.001	9.275–9.475	6.3,.8	15k,15		1	36kw
THF1026	osc,.001	8.5–9.6	13.75,3.4	24k,25		1	200kw
TH2J51A	osc,.0011	8.5–9.6	6.3,1	15k,15.5		3.5	44kw
THF1050	osc,.0012	5.45–5.825	9.5,5.5	28k,30		1	250kw
TH1501	osc,.0005	5.35–5.5	9.5,5.5	30k,33		1	400kw
TH2J26	osc,.002	2.992–3.019	6.3,1.5	22k,30		1	240kw
TH2J27	osc,.002	2.965–2.992	6.3,1.5	22k,30		1	240kw
TH2J30	osc,.002	2.86–2.9	6.3,1.5	22k,30		1	240kw
TH2J31	osc,.002	2.82–2.86	6.3,1.5	22k,30		1	240kw
TH2J32	osc,.002	2.78–2.82	6.3,1.5	22k,30		1	240kw
TH2J33	osc,.002	2.74–2.78	6.3,1.5	22k,30		1	240kw
TH2J34	osc,.002	2.7–2.74	6.3,1.5	22k,30		1	240kw
TH5586	osc,.001	2.7–2.9	16,3.1	32.5,70		1	800kw
TH5657	osc,.001	2.9–3.1	16,3.1	32.5,70		1	800kw
THF1001	osc,.001	3.1–3.3	16,3.1	32.5,70		1	800kw
THF1007	osc,.001	2.97–3.03	16,3.1	32.5,70		4	1megw
TH1658A	osc,.001	2.9–2.93	16,3.1	32.5,70		4	1megw
TH1658B	osc,.001	3.05–3.08	16,3.1	32.5,70		4	1megw
TH5J26	osc,.002	1.22–1.35	23.5,2.2	31,60		1	400kw

COMPAGNIE GENERALE DE T.S.F. 79 Boulevard Haussman, Paris 8, France

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
4J52A	osc,.001	9.345–9.405	12.6,2.2	15k,15		1	75kw
4J50A	osc,.001	9.345–9.405	13.75,3.3	21.5k,27.5		.5	240kw
F1002	osc,.001	8.5–9.6	12.6,2.2	15k,15		1	70kw
MCV602	osc,.001	8.5–9.6	12.6,2.2	15k,15		1	70kw
F1005	osc,.001	8.5–9.6	9,2.6	22k,27.5		1	220kw
F1026	osc,.001	8.5–9.6	9,2.6	22k,27.5		1	200kw
F1057	osc,.0005	2.925–3.525	5.3,2.6	29k,42		1	400kw
F1008	osc,.001	2.897–3.228	14,5.6	31k,65		2	1.2megw
F1030	osc,.001	2.897–3.228	14,5.6	31k,65		4	1.2megw
F1084	osc,.001	2,9–3.015	14,5.6	30k,65		2.2	1.1megw
F1085	osc,.001	3–3.115	14,5.6	30k,65		2.2	1.1megw
F1086	osc,.001	3.085–3.2	14,5.6	30k,65		2.2	1.1megw
F1054	osc,.001	2.9–3.015	14,5.6	30k,65		4.4	1.1megw

COMPAGNIE GENERALE DE T.S.F. – *(Continued)*

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
F1055	osc,.001	3–3.11	14,5,6	30k,65		4.4	1.1megw
F1056	osc,.001	3.085–3.2	14,5.6	30k,65		4.4	1.1megw
MCV101C1	osc,.1	3.3–3.4	6.3,1.2	1.3k,.6		1	.15kw
MCV101D1	osc,.1	3.5–3.6	6.3,1.2	1.3k,.6		1	.15kw
MCV85D1	osc,.1	3.5–3.6	4.5,2.1	1.4k,.5		1	.32kw
MCV85D2	osc,.1	3.6–3.7	4.5,2.1	1.4k,.5		1	.32kw
MC567	osc,.0015	1.27–1.37	20,13	42k,150		5	2.5megw

EITEL-McCULLOUGH, INC., San Carlos, Calif.

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
X747	v. tun	0.4–1					100mw

EMI ELECTRONICS, LTD., Hayes, Middlesex, England

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
R6138	pkgd	Q-band	6.3,3	13k,.004	40	.2	18kw
R9515	pkgd	Q-band	6.3,5	14k,.006	75	.2	40kw

ENGLISH ELECTRIC VALVE CO., LTD., Chelmsford, England

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
2J30–34	mult,,002	2.7–2.9	6.3,1.5	20k,30	15	1	300kw
2J42	mult,.002	9.345–9.405	6.3,.5	5.5k,4.5	15	1	8kw
2J55	mult,.001	9.345–9.405	6.3,1	12k,12	15	1	45kw
2J56	mult,.001	9.215–9.275	6.3,1	12k,12	15	1	45kw
4J31–35	mult,.001	2.7–2.9	16,3.1	28k,70	15	1	1megw
4J43-44	mult,.001	2.965–3.019	16,3.1	28k,70	15	1	900kw
4J50A	mult,.001	9.345–9.405	13.75,3.25	22k,25	15	1	225kw
4J52A	mult,.001	9.350–9.4	12.6,2.2	15k,15	13	1	80kw
4J53	mult,.001	2,793–2.813	16,3.1	28k,70	15	1	1megw
4J78	mult,.002	9.003–9.168	13.75,3.5	21.5k,27.5	15	1	250kw
5586	mult,.001	2.7–2.9	16,3.1	30k,70	15	1	1megw
5657	mult,.001	2.9–3.1	16,3.1	30k,70	15	1	1megw
6027	mult,.002	9.345–9.405	6.3,.5	6.9k,7	15	1	20kw
7182	mult,.001	2.75–2.86	12,15	35k,157	7	5	2.5megw
M501	mult,.001	2,94–3.06	5,2.6	27k,35	35	2	500kw
M501A	mult,.001	2.94–3.06	5,2.6	27k,35	35	2	500kw
M501B	mult,.001	2.94–3.06	5,2.6	27k,35	35	2	500kw
M502A	mult,.0005	9.325–9.425	12.6,2.25	21k,22.5	15	1	180kw
M503A	mult,.002	9.345–9.405	6.3,.5	5.5k,4.5	15	.1	8kw
M504	mult,.0006	9.325–9.425	5,40	35k,50	15	.6	750kw
M505	mult,.001	9.36–9.46	3,3.5	11.1k,12	15	1	45kw
M506A	mult,.001	9.36–9.46	3,3.5	11.2k,12	15	1	50kw
M507	mult,.001	3.23–3.38	5,2.6	27k,40		.5	425kw
M508	mult,.001	9.21–9.27	6.3,.5	5.5k,4.5	15	1	8kw
M509	mult,.001	8.77–8.83	6.3,.5	5.5k,4.5	15	2	8kw
M513A	mult,.0005	9.345–9.405	6.3,.5	7.5k,7.5	15	1	22kw
M519	mult,.0002	3.45–3.614	5,2.6	27k,40		.5	425kw
M521	mult,.001	9.6–9.7	3,3.5	11.1k,12	15	1	45kw
M523	mult,.001	9.58–9.705	13.75,3.25	22k,25	15	1	225kw
M525	mult,.001	2.75–2.855	8.5,9	36k,70	7	1	1.15megw
M528	mult,.001	3–3.12	6,1.25	22.5k,22.5	7	.5	200kw
M529	mult,.001	8.83–8.995	13.75,3.25	22k,25	15	1	225kw
M535	mult,.0001	9.5–9.6	6.3,.5	5.5k,4.5	15	1	7.2kw
M537	mult,.0002	8.77–8.83	6.3,.5	5.5k,4.5	15	1	8kw
M538A	mult,.001	9.21–9.27	13.75,3.25	22k,25	15	1	225kw
M539	mult,.001	8.665–8.83	13.75,3.25	22k,25	15	1	225kw
M546	mult,.001	9.7–9.85	13.75,3.25	22k,25	15	1	225kw
M547	mult,.001	9.85–10	13.75,3.25	22k,25	15	1	225kw
M548	mult,.001	9.003–9.168	3,3.5	13.5k,12	12	1	50kw
M549	mult,.001	8.5–8.665	13.75,3.25	22k,25	15	1	225kw
M554	mult,.001	1.297–1.365	20,13.5	39k,150	4	5	2.6megw
M555	mult,.001	14–16.5	12.6,2.25	16k,15	25	1	65kw
M558	mult,.0025	9.345–9.405	6.3,.5	5.5k,4.5	16	.1	8kw
M559	mult,.0025	9.345–9.405	6.3,.5	7.2k,7	15	1	20kw
M561	mult,.002	3.04–3.06	10,1.1	15k,15	6	2	80kw
M565	mult,.002	1.215–1.365	48,14	48k,240		10	5megw
M566	mult,.001	2.75–2.86	12,15	38.5k,145	7	5	2.5megw
M569	mult,.001	2.85–2.96	12,15	40k,140	7	5	2.5megw
M570	mult,.001	2.95–3.06	12,15	40k,140	7	5	2.5megw
M573	mult,.001	2.85–2.96	12,15	38k,144	7	5	2.5megw
M574	mult,.001	2.95–3.06	12,15	41k,132	7	5	2.5megw
M577	mult,.0005	3–3.04	16,3.1	28k,70	15	1	900kw
M578	mult,.0005	3.06–3.1	16,3.1	28k,70	15	1	900kw

GENERAL ELECTRIC CO., Power Tube Dept., Schenectady 5, N.Y.

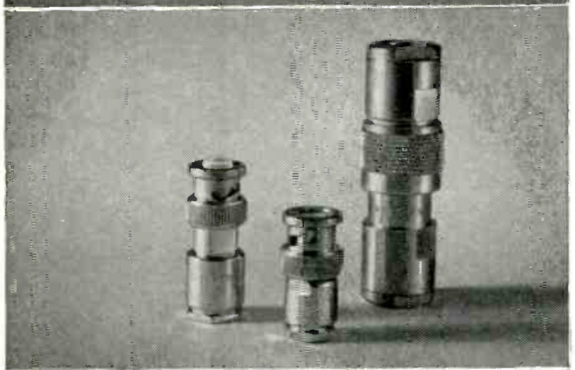
Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
GL7398	pkgd	2.2–3.85	2.5,3	2k,.03		cw	2w
Z5266	pkgd	2.35–3.6	2,6.3	2k,.04		cw	.5mw
Z5337	pkgd	2.9–3.1	2,2.5	1k,.025		cw	4w
Z5360	pkgd	2.8–3.5	2,6.3	2k,.03		cw	100mw
Z5405	pkgd	1–2.3	2.5,3	2k,.02		cw	1w
Z5424	pkgd	2.9–3.2	2.5,2.7	2.4k,.07		cw	50w
Z5428	pkgd	2.2–2.3	2.37,3	2.5k,.04		cw	10w
Z5429	pkgd	8.5–11	2.5,3	2k,.03		cw	1mw
Z5436	pkgd	2.4–3.3	2.6,3	1.5k,.03		cw	5mw
ZM6000	pkgd	2.09–2.41	2.57,3	2.5k,.04		cw	10w
ZM6001	pkgd	1.625–1.7	2,2.5	500,.02		cw	2w
ZM6003	pkgd	4.2–4.4	2,2.5	1k,.025		cw	2w
ZM6006	pkgd	2.8–3.2	2,2.5	1k,.025		cw	3w
ZM6011	pkgd	1.375–1.625	2,6.3	2k,.04		cw	5w
ZM6014	pkgd	.5–1.2	2.8,3	2.5k,.02		cw	.5w
ZM6015	pkgd	5.175–5.425	2,6.3	2.5k,.04		cw	10w
ZM6019	pkgd	2.5–3.5	2.5,3	2.5k,.03		cw	10w
ZM6022	pkgd	2.2–2.3	2.48,3	2.5k,.04		cw	10w

LITTON INDUSTRIES, Electron Tube Div., San Carlos, Calif.

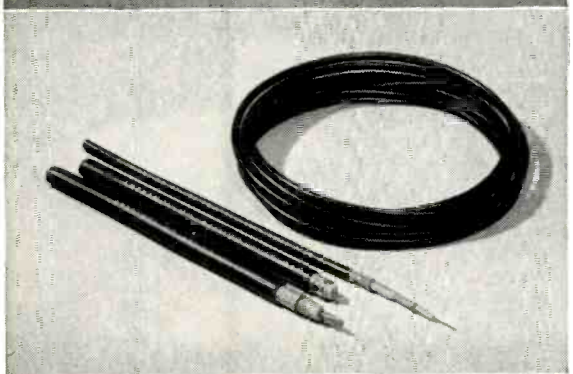
Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
LT4J50A	plsd,.1%	9.375	13.75,3.35	21.5k,27.5			225kw
L3039D	plsd,.1%	8.8	13.75,3.35	21.5k,27.5			225kw
L3039E	plsd,.1%	8.86	13.75,3.35	21.5k,27.5			225kw
L3039F	plsd,.1%	8.92	13.75,3.35	21.5k,27.5			225kw
L3039G	plsd,.1%	8.98	13.75,3.35	21.5k,27.5			225kw
L3039H	plsd,.1%	9.04	13.75,3.35	21.5k,27.5			225kw
L3039I	plsd,.1%	9.1	13.75,3.35	21.5k,27.5			225kw

Now...a single source of supply for

DK* Coaxial Switches and FXR Waveguide Switches



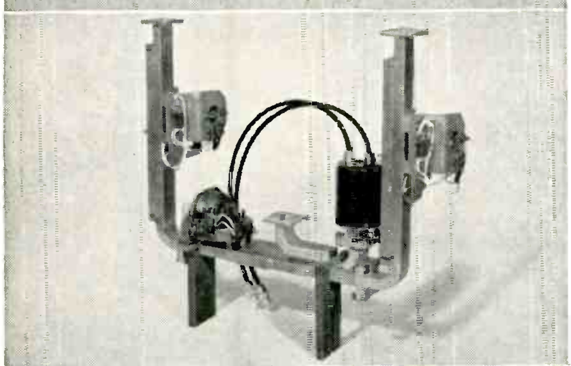
AMPHENOL* and ipc Coaxial Connectors



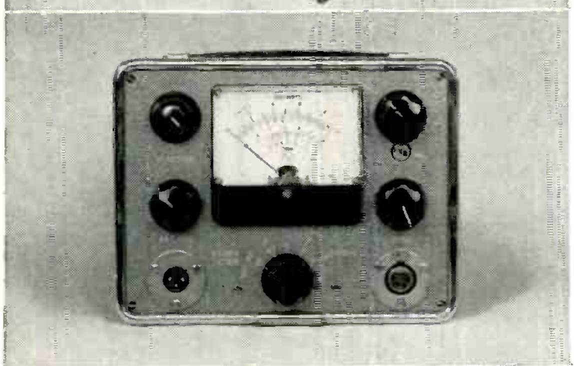
AMPHENOL Cable and Wire

FXR

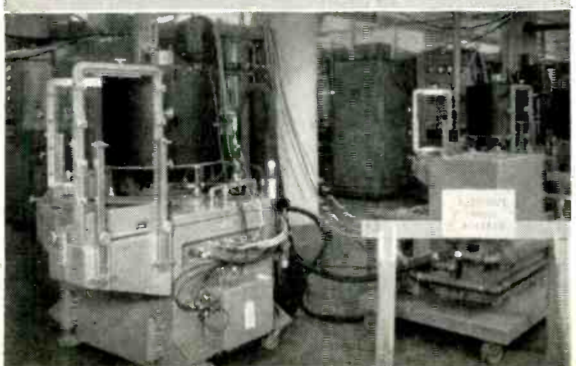
THE RF PRODUCTS AND MICROWAVE DIVISION AMPHENOL-BORG ELECTRONICS CORPORATION



FXR Microwave Components



FXR Microwave Test Equipment



FXR High-Power Electronics and Microwave Sub-Systems

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Circle 76 on Inquiry Card

MICROWAVE ELECTRON DEVICES

MAGNETRONS – *(Continued)*

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
LITTON INDUSTRIES, – *(Continued)*							
L3039J	plsd,.1%	9.16	13.75,3.35	21.5k,27.5			225kw
L3039K	plsd,.1%	9.22	13.75,3.35	21.5k,27.5			225kw
L3039L	plsd,.1%	9.28	13,75,3.35	21.5k,27.5			225kw
L3039M	plsd,.1%	9.34	13.75,3.35	21.5k,27.5			225kw
L3039N	plsd,.1%	9.4	13.75,3.35	21.5k,27.5			225kw
L3039P	plsd,.1%	9.375	13.75,3135	21.5k,27.5			225kw
L3039R	plsd,.1%	8.79	13.75,3135	21.5k,27.5			225kw
L3613	plsd,.1%	9.375	13.75,3135	21.5k,27.5			225kw
L3103	plsd,.2%	8.5–9.6	12.6,2.3	12.5k,10			30kw
LT6543	plsd,.1%	8.5–9.6	12,6,2.3	15k,15			65kw
L3030	plsd,.1%	9.375	13.75,3.35	27.5k,27.5			300kw
L3030B	plsd,.1%	9	13.75,3.35	27.5k,27.5			300kw
L3030C	plsd,.1%	9.2	13.75,3.35	27.5k,27.5			300kw
L3306	plsd,.1%	16.5	12.6,2.4	12k,12			30kw
L3326	plsd,.1%	16.5	12.6,2.4	17k,16			60kw
L3089	plsd,25%	8.8	6.3,.9	850,.2			40w
L3358	plsd,.3%	16–16.5	6.3,.95	3k,2			1kw
L3383	plsd,.3%	16.25–16.3	6.3,.95	3k,2			1kw
L3496	plsd,.3%	16–16.5	6.3,.7	3k,1.6			1kw
L3359	plsd,.3%	16–16.5	6.3,.95	3.6k,2.75			2kw
L3498	plsd,.3%	16.28–16.32	6.3,.95	3.6k,2.75			2kw
L3452	plsd,.3%	16.2	6.3,.96	3.6k,2.75			2.2kw
L3602	plsd,2.7%	8.6	6.3,.6	550,.3			30w
L3105	plsd,2.7%	9.3	6.3,.5	800,.55			100w
L3434	plsd,2.7%	9.95	6.3,.5	800,.55			100w
L3603	plsd,2%	9.3	6.3,.5	1.3k,1.3			500w
L3429	plsd,.5%	9.3	6.3,.5	1.4k,2.2			1kw
L3604	plsd,.3%	9.3	6.3,.5	2.8k,1.33			1kw
L3238	plsd,.3%	9.34	6.3,.5	2.8k,1.33			1kw
L3239	plsd,.2%	9.3	6.3,.5	3.3k,2.25			2kw
L3605	plsd,.1%	9.3	6.3,.5	3.6k,3.15			3kw
L3268	plsd,.1%	9.3	6.3,.9	3.9k,4			4kw
L3212	plsd,2.7%	9–9.02	6.3,.5	800,.55			120w
L3213	plsd,2.7%	9.05–9.07	6.3,.5	800,.55			120w
L3214	plsd,2.7%	9.1–9.12	6.3,.5	800,.55			120w
L3218	plsd,2.7%	9.15–9.17	6.3,.5	800,.55			120w
L3226	plsd,2.7%	9.18–9.2	6.3,.5	800,.55			120w
L3180	plsd,2.7%	9.2–9.22	6.3,.5	800,.55			120w
L3181	plsd,2.7%	9.25–9.27	6.3,.5	800,.55			120w
L3028D	plsd,2.7%	9.28–9.33	6.3,.5	800,.55			120w
L3601	plsd,2.7%	9.315–9.34	6.3,.5	800,.55			120w
L3327	plsd,2.7%	9.365–9.385	6.3,.5	800,.55			120w
L3187	plsd,2.7%	9.25–9.27	5,.6	800,.55			120w
L3087A	plsd,2.7%	9.28–9.32	5,.6	800,.55			120w
L3384	plsd,.3%	9.28–9.32	6.3,.5	2.8k,1.33			1kw
L3058	plsd,.3%	9.3–9.32	6.3,.5	2.8k,1.33			1kw
L3225	plsd,.3%	9.31–9.35	6.3,.5	2.8k,1.33			1kw
L3606	plsd,1.%	9.3	6.3,.9	1.3k,1.3			500w
L3430	plsd,.5%	9.3	6.3,.9	1.4k,2.2			1kw
L3379	plsd,.3%	8.8–9.5	6.3,.9	3.35k,1.15			1kw
L3380	plsd,.2%	8.8–9.5	6.3,.9	3.45k,2.25			2kw
L3381	plsd,.1%	8.8–9.5	6.3,.9	3.6k,3.25			3kw
L3382	plsd,.1%	8.8–9.5	6.3,.9	4k,4			4kw
L3168	plsd,.2%	9.375	12.6,2.3	12.5k,10			30kw
LT4J52A	plsd,.1%	9.375	12.6,2.3	15k,15			70kw
LT6510	plsd,.1%	9.375	12.6,2.3	15k,15			65kw
L3036A	plsd,.1%	9.41	12.6,2.3	15k,15			65kw
L3036B	plsd,.1%	9.275	12.6,2.3	15k,15			65kw
L3036F	plsd,.1%	9.245	12.6,2.3	15k,15			65
L3305	plsd,.1%	8.5–9.6	12.6,2.3	15k,15			65kw
L3083A	plsd,.1%	16–17	12.6,2.4	17k,16			60kw
L3083B	plsd,.1%	16–17	12.6,2.4	17k,16			60kw
L3083C	plsd,.1%	16–17	12.6,2.4	17k,16			60kw
L3101A	plsd,.1%	16–17	12.6,2.4	17k,16			60kw
L3101B	plsd,.1%	16–17	12.6,2.4	17k,16			60kw
L3101C	plsd,.1%	16–17	12.6,2.4	17k,16			60kw
L3023	plsd,.3%	9.28–9.345	6.3,1	5.8k,3.8			7kw
L3029A	plsd,.3%	9.235–9.3	6.3,1	5.8k,3.8			7kw
L3029B	plsd,.3%	9.25–9.315	6.3,1	5.8k,3.8			7kw
L3029C	plsd,.3%	9.295–9.36	6.3,1	5.8k,3.8			7kw
L3029D	plsd,.3%	9.295–9.33	6.3,1	5.8k,3.8			7kw
L3312	plsd,.1%	8.5–9.6	13.75,3.35	21.5k,27.5			200kw
L3313	plsd,.1%	8.5–9.6	13.75,3.35	21.5k,27.5			200kw
L3431	plsd,.1%	9.375	6.3,1.3	7k,7			18kw
L3456	cw,plsd	.35–.59	5.5	4k,.2			300w
L3459	cw,plsd	.59–.975	5.5	4k,.2			300w
L3465	cw,plsd	.975–1.5	5.5	4k,.3			400w
L3464	cw,plsd	1.5–2.35	5.5	4k,.325			400w
L3460	cw,plsd	2.35–3.575	5.5	4k,.3			500w
L3461	cw,plsd	3.575–4.975	5.5	4k,.25			350w
L3467	cw,plsd	4.975–6.175	5.5	4.2k,.25			400w
L3468	cw,plsd	6.175–7.275	5.5	4.2k,.2			300w
L3462	cw,plsd	7.275–8.775	5.5	4.4k,.2			300w
L3463	cw,plsd	8.775–10.475	5.5	4.4k,.2			250w
L3500	cw,plsd	.35–.59	5.5	3.2k,.13			110w
L3501	cw,plsd	.59–.975	5.5	3.2k,.13			110w
L3502	cw,plsd	.975–1.5	5.5	3.2k,.13			110w
L3503	cw,plsd	1.5–2.35	5.5	3.2k,.13			110w
L3504	cw,plsd	2.35–3.575	5.5	3.2k,.13			110w
L3505	cw,plsd	3.575–4.975	5.5	3.2k,.13			110w
L3506	cw,plsd	4,975–6.175	5.5	3.2k,.13			110w
L3507	cw,plsd	6.175–7.275	5.5	3.2k,.13			110w
L3508	cw,plsd	7.275–8.775	5.5	3.2k,.13			110w
L3509	cw,plsd	8.775–10.475	5.5	3.2k,.13			110w
METCOM, INC., 76 Lafayette St., Salem, Mass.							
MCM11	tun,.002	5.4–5.9		1.3k,.8		1	100w
MCM10	fix,.0003	5.5–5.6		7.5k,4		.2	10kw

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
METCOM, INC., – *(Continued)*							
MCM23	tun,.002	5.4–5.9		2k,1.1		1	400w
MCM13	tun,.002	5.4–5.9		2.8k,1.9		1	1kw
MCM12	tun,.002	5.4–5.9		2k,1.1		1	400w
MCM14	tun,.002	5.4–5.9		2.2k,1.1		1	500w
MCM15	tun,.002	5.4–5.9		2k,1.1		1	400w
MCM16	tun,.002	5.4–5.9		2.8k,1.9		1	1kw
MCM18	tun,.002	5.4–5.9		2.5k,1.5		1	700w
MCM19	tun,.002	5.4–5.9		2.8k,1.9		1	900w
MCM20	tun,.002	5.5–5.8		500,.19		1	25w
MCM21	tun,.002	5.4–5.9		2.5k,1.5		1	550w
MCM22	tun,.002	5.4–5.9		3k,1.9		1	900w
MXM19	tun,.002	9.1–9.5		1.3k,.9		1	100w
MXM10	fix,.0015	9.345–9.405		2.8k,1.5		.25	800w
MXM11	tun,.002	9.1–9.5		1.2k,.8		1	100w
MXM12	fix,.0015	9.345–9.450		3.7k,4.33		.2	3.5kw
MXM13	tun,.002	8.5–8.9		1.2k,.9		1	100w
MXM14	tun,.002	8.9–9.6		1.2k,.9		1	100w
MXM15	fix,.0015	9.345–9.405		2.8k,5.2		.25	3kw
MXM16	tun,.002	8.8–9.6		2.8k,2		1	1kw
MXM20	fix,.002	9.345–9.405		2.6k,2		1	1kw
MXM21	fix,.002	9.345–9.405		3k,4		1	2.5kw
MXM22	tun,.002	8.9–9.6		2.6k,2		1	1kw
MXM23	tun,.002	8.5–8.9		2.6k,2		1	1kw
MXM24	tun,.002	8.9–9.6		3k,4		1	2.5kw
MXM25	tun.,002	8.5–8.9		3k,4		1	2.5kw
MICROWAVE ASSOCIATES, INC., Burlington, Mass.							
MA221B	fix,cw	7.5–8.8		450,.015			1.5w
MA212B	fix,cw	8.8–10		460,.015			1.5w
MA217B	tun,cw	7.5–8.5		470,.02			1w
MA219B	tun,cw	8.5–9.6		470,.02			1w
MA214B	tun,cw	9–10		470,.02			1w
MA231B	fix,cw	7.5–8.8		930,.055			20w
MA232B	fix,cw	8.8–10		903,.055			20w
MA221A	fix,.01	7.5–8.8		500,.15		1	10w
MA221C	fix,.01	7.5–8.8		500,.15		5	10w
MA221D	fix,.005	7.5–8.8		530,.3		1	20w
MA212A	fix,.01	8.8–10		520,.15		1	10w
MA212C	fix,.01	8.8–10		502,.15		5	10w
MA212D	fix,.005	8.8–10		560,.3		1	20w
MA217A	tun,.005	7.5–8.5		530,.15		1	10w
MA217C	tun,.005	7.5–8.5		560,.3		1	20w
MA219A	tun,.005	8.5–9.6		530,.15		1	10w
MA219C	tun,.005	8.5–9.6		560,.3		1	20w
MA214C	tun,.005	9–10		540,.15		1	8w
MA214D	tun,.005	9–10		570,.3		1	16w
MA208	tun,.02	7.125–8.5		800,.2		3	20w
MA205	fix,.25	8.775–8.825		800,.2		5	40w
MA215	fix,.05	8.8–9.6		900,.5		1	100w
MA231A	fix,.05	7.5–8.8		1k,.75		1	200w
MA232A	fix,.05	8.8–10		1k,.75		1	200w
6229	tun,.0005	8.9–9.4		4k,.5		.25	400w
6230	tun,.003	8.9–9.4		4.3k,.8		1	900w
7521	tun,.003	8.9–9.4		4.3k,.9		.2	800w
MA222	fix,.002	9.345–9.405		5.5k,4.5		1	7kw
MA209A	tun,.002	9.3–10		5.8k,4.5		1	7kw
MA218	tun,.002	9.3–10		5.8k,4.5		1	7kw
MA226	fix,.0005	33–33.4		12k,10		.25	16kw
MA225	tun,.0004	32.95–33.45		12k,20		.25	32kw
MA224	fix,.00025	33–33.4		12k,20		.25	32kw
MA227A	fix,.0008	33–33.4.		12k,10		.25	20kw
MA227B	fix,.0008	33.6–35.1		12k,10		.25	20kw
MA206	fix,.0005	34.7–35		12k,10		.25	16kw
MA210A	tun,.0004	34.2–34.7		12k,20		.25	32kw
MA210B	tun,.0004	34.6–35.1		12k,20		.25	32kw
MA210C	tun,.0004	35–35.5		12k,20		.25	32kw
MA200	fix,.00025	34.7–35		12k,20		.25	32kw
5789	fix,.00025	34.5–35.2		12.5k,20		.25	32kw
MA207A	fix,.0004	34.7–35		13k,20		.25	50kw
MA220	tun,.0003	5.625–5.675		10k,12		10	40kw
NIPPON ELECTRIC CO., LTD., Tokyo, Japan							
2J42	fix,.002	9.345–9.405	6.3,.52	5.5k,4.5	15	1	8kw
2J42A	fix,.001	9.345–9.405	6.3,.52	6.9k,7.5	15	1	20kw
2J42H	fix,.00036	9.345–9.405	6.3,.52	5.275k,4.5	20	.45	7kw
2J49	fix,.001	9–9.16	6.3,1	12k,12	15	2	50kw
2J50	fix,.001	8.75–8.9	6.3,1	12k,12	15	2	50kw
2J55	fix,.001	9.345–9.405	6.3,1	12k,12	15	2	50kw
2J56	fix,.001	9.215–9.275	6.3,1	12k,12	15	2	50kw
725A	fix,.001	9.345–9.405	6.3,1	12k,12	15	2	50kw
4J52A	fix,.001	9.35–9.4	12.6,2.2	15k,15	15	2	80kw
6249B	tun,.001	8.5–9.6	9,14.2	28k,25	15	2.5	240kw
5795	tun,.0013	3.1–3.5	107,3.65	46k,46	10	1.33	1megw
QK428A	fix,.0006	2.85–2.91	8.3,85	52k,85	10	2	2megw
QK338A	fix,.001	2.75–2.86	7.65,76	70k,130	15	2	5megw
25M10	fix,.0006	24.255–24.745	5,2.9	14k,15	30	.15	40kw
35M10	fix,.00025	34.512–35.208	6,2	13k,20	40	.25	40kw
RADIO CORPORATION OF AMERICA, Electron Tube Div., Harrison, N.J.							
6521	osc,.0008	5.4±20mc		16k,16			75kw
7008	osc,.001	8.5–9.6		23k,27.5			200kw
7111	osc,.001	8.5–9.6		23k,27.5			200kw
A1135	osc,.002	8.5–9.6		23k,27.5			190kw
A1127	osc,.001	8.5–9.6		28k,27.5			250kw
6865A	osc,.001	8.75–9.6		23k,27.5			190kw
4011A	osc,.001	8.75–9.6		23k,27.5			215kw
A1163	osc,.001	8.75–9.6		23k,27.5			215kw
A1150	osc,.027	9.28–9.32		.9k,.55			140w

MAGNETRONS—*(Continued)*

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;A	Pull. Fac. (mc/s)	Pls. Dur. (μs)	Power Output
RAYTHEON CO., Microwave & Power Tube Div., Waltham, Mass.							
QK172	osc,.001	9.33–9.42		30k			440kw
QK324	osc,.0028	15.8–16.1		30k,14			70kw
QK366	osc,.001	9.2–9.28		16k,14.5			75w
QK456	osc,.001	5.3–5.4		16k,20			75kw
QK470	osc,.0012	1.2–1.3		75k,100			2mw
QK366A	ampl,.001	9.245 ±.04		15k,13.5		0.5	100kw
QK665	fix,.0018	1.25–1.285	15,150	72k,150		5	9.9kw
QK666	fix,.0018	1.32–1.35	15,150	72k,150		5	9.9kw
QK735	tun,.003	5.4–5.9	5,1	2.3k,1.5		1	400w
RK5J26	tun,.002	1.22–1.35	23.5,2.2	31k,60		4	400kw
RK6517	tun,.0013	1.25–1.35	2.5,85	70k,60		3	1000kw
RK4J62	tun	2.695–3.015	6.3,3.5	1.5k,0.15			50kw
RK2J34	fix,.002	2.7–2.74	6.3,1.5	22k,30		1	240kw
RK4J35	fix,.001	2.7–2.74	16,3.1	30k,70		1	800kw
RK5586	tun,.001	2.7–2.9	16,3.1	32k,70		1	700kw
RK2J33	fix,.002	2.74–2.78	6.3,1.5	22k,30		1	240kw
RK4J34	fix,.001	2.74–2.78	16,3.1	30k,70		1	800kw
RK6410	fix,.001	2.75–2.86	8.3,85	76k,135		2	4500kw
RK2J32	fix,.002	2.78–2.82	6.3,1.5	22k,30		1	240kw
RK4J33	fix,.001	2.78–2.82	16,3.1	30k,70		1	800kw
RK2J31	fix,.002	2.82–2.86	6.3,1.5	22k,30		1	240kw
RK2J32	fix,.001	2.82–2.86	16,3.1	30k,70		1	800kw
RK6406	fix,.0006	2.25–2.91	8.3,85	56k,95		2	1750kw
RK2J30	fix,.002	2.86–2.9	6.3,1.5	22k,30		1	240kw
RK4J31	fix,.001	2.86–2.9	16,3.1	30k,70		1	800kw
RK5657	tun,.001	2.9–3.1	16,3.1	32.5k,70		1	700kw
RK4J63	tun	2.985–3.335	6.3,3.5	1.5k,0.15			50w
RK2J70	fix,.002	3.03–3.11	6.3,1.25	7.5k,15			20kw
RK4J64	tun	3.305–3.675	6.3,3.5	1.5k,0.15			50w
RK6403	tun,.0014	3.43–3.57	8.3,43	65k,90			200kw
RK6177	osc	4.268–4.35	6.3,0.6	350,.035			11w
RK6344	tun,.001	5.45–5.825	11,11	24k,30			175kw
RK2J51A	tun,.0011	8.5–9.6	6.3,1	16k,15.5			40kw
RK6249	tun,.0013	8.5–9.6	9,14.4	32k,32			200kw
RK6229	tun,.003	8.9–9.4	5,0.45	5k,1			400w
RK2J56A	fix,.001	9.215–9.275	6.3,1	16k,16			40kw
RK6002	fix,.002	9.230–9.404	4,40	30k,40			225kw
RK2J55	fix,.001	9.345–9.405	6.3,1	16k,16			40kw
RK2J42	fix,.0025	9.345–9.405	6.3,0.5	6k,5.5			7kw
RK6841	fix,.001	16.41–16.625					
2J30	osc,.002	3.1–2.7		22k,30			240kw
2J31	osc,.002	3.1–2.7		22k,30			240kw
2J32	osc,.002	3.1–2.7		22k,30			240kw
2J33	osc,.002	3.1–2.7		22k,30			240kw
2J34	osc,.002	3.1–2.7		22k,30			240kw
2J42	osc,.002	9.3–9.4		5.7k,4.5			8kw
2J51	osc,.0012	8.5–9.6		16k,16			45kw
2J55	osc,.001	9.3–9.4		16k,16			40kw
2J56	osc,.001	9.21–9.27		16k,16			40kw
4J35	osc,.001	2.7–2.9		30k,70			800kw
4J34	osc,.001	2.7–2.9		30k,70			800kw
4J33	osc,.001	2.7–2.9		30k,70			800kw
4J32	osc,.001	2.7–2.9		30k,70			800kw
4J31	osc,.001	2.7–2.9		30k,70			800kw
4J63	osc	2.98–3.33		1.5k,.15			50w
4J64	osc	3.3–3.6		1.5k,.15			50w
2J70	osc,.002	3–3.1		7.5k,15			20kw
4J62	osc	2.6–3					
5J26	osc,.002	1.2–1.3		31k,60			400kw
6002	osc,.002	9.2–9.4		30k,40			225kw
6177	osc	4.2–4.3		350,.025			1w
RAYTHEON CO.,—*(Continued)*							
6229	osc,.003	8.9–9.4		5k,1			400w
6249	osc,.0013	8.5–9.6		29k,32			200kw
6344	osc,.001	5.45–5.825		24k,30			175kw
6402	osc,.0016	3.4–3.5		57k,55			700kw
6406	osc,.0006	2.8–2.9		56k,95			1.75megw
6410	osc,.001	2.7–2.8		76k,135			1.5megw
6517	osc,.0013	1.2–1.3		70k,60			1megw
6841	osc,.001	1.64–1.66		19k,16			50kw
5586	osc,.001	2.7–2.9		30k,70			800kw
5657	osc,.001	2.9–3.1		33k,70			700kw
6695	osc,.001	3.43–3.57		33k,65			650kw
6403	osc,.001	3.43–3.57		65k,90			2megw
QKH517B	osc,.0018	.535–.545		50k,90		6	2megw
QKH626	osc,.0018	.57–.63		50k,90		6	2megw
QKH517A	osc,.0018	.60–.61		50k,90		6	2megw
QKH517	osc,.0018	.67–.68		50k,90		6	2megw
QKH959	cw	.95–1.525		2.9k,.225			190w
RK7484A	tun,.001	1.25–1.35		60k,90		3	2megw
QKH942	tun,.0018	1.25–1.35		71k,150		5	5megw
QKH960	cw	2.35–3.6		2.9k,225			190w
RK7529	tun,.00072	2.7–2.85		62k,115		2	3.5megw
QKH883	osc,.001	2.75–2.86		70k,130		2	45megw
QKH898	osc,.001	2.846–2.866		70k,130		2	4.5megw
QKH632	osc,.001	5.25–5.31		35k,60		2.5	1megw
QKH821	tun,.002	5.4–5.9		3.45k,2.75		0.75	2.5kw
RK7578	tun,.002	5.4–5.9		2.8k,2		0.75	800kw
QKH737	tun,.0003	5.43–5.57		1.67k,1.1		0.3	225kw
QKH539	osc,.001	5.45–5.51		35k,60		1	1megw
RK7156	tun,.001	5.45–5.825		25k,24		2	250kw
RK7460	tun,.0003	5.45–5.825		24.5k,25		0.5	250kw
RK7417	osc,.0003	5.5–5.6		7.5k,4		0.2	10kw
QKH1000	tun,.001	8.5–9.6		28k,25		2.5	200kw
QKH788	tun,.001	8.5–9.6		28k,25		2.5	200kw
QKH1001	tun,.001	8.5–9.6		28k,25		2.5	200kw
RK6248	tun,.045	8.7–8.9		3.55k,0.91		1	1.1kw
RK7521	tun,.001	8.9–9.4		4.25k,0.9		0.2	800w
QKH790	tun,.001	8.9–9.4		4.5k,1.0		0.5	1kw
QKH736	tun,.0003	9.13–9.27		1.87k,1.1		0.3	200kw
RK7718	osc,.0009	9.34–9.44		39k,69		2	1megw
QKH798	osc,.0003	9.36–9.46		5.2k,3.5		0.2	3kw
RK7630	osc,.0022	15.84–16.16		24k,12		0.35	85kw
RK7449	osc,.0003	23.78–24.3		14k,15		.07	45kw
RK6551	osc,.0006	23.8–24.27		14k,15		.15	40kw
SFD LABORATORIES, INC., 800 Rahway Ave., Union, N.J.							
SFD303	osc,.001	9.375	26.8	33kv,60	6		1megw
WESTINGHOUSE, Electronic Tube Div., P.O. Box 284, Elmira, N.Y.							
WL6177	osc,cw	4.268–4.35	6.3,0.6	315,.030	4		1w
WL6285	osc,.0018	1.31		70k,350		10	6.5megw
WL7008	osc,.001	8.5–9.6	13.7,3.1	22k,27.5	10	2.8	220kw
WL7796	osc,cw	4.2–4.4	6.3,0.6	350,.030			2w
WL7794	osc,cw	4.2–4.4	6.3,0.6	425,.030			10wp
WL7795	osc,cw	4.2–4.4	6.3,0.6	425,.030			10wp
WL7110	osc,.001	8.5–9.6	13.7,3.1	22k,27.5	10	2.8	220kw
WL7111	osc,.001	8.5–9.6	13.7,3.1	22k,27.5	10	2.8	220kw
WL7112	osc,.001	8.5–9.6	13.7,3.1	22k,27.5	10	2.8	220kw
WL7541	osc,.001	8.5–9.6	9.0,14	28k,25	12	1.1	250kw
WL6249B	osc,.001	8.5–9.6	9.0,14	28k,25	12	3.3	240kw
WL6865	osc,.001	8.5–9.6	13.7,3.1	22k,27.5	10	2.8	220kw

PLANAR TRIODES AND TETRODES

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;MA	Ampl Fac	Max. Diss.	Power Output
AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L.I., N.Y.							
7377	twin tetr	.96	6.3,.6	250,2x40			5w
TBL2/500	tri ampl	1	3.4,1.9	2k,400		500w	
6907	twin tetr	.6	6.3,1.3	400,2x50		25w	15w
6252	twin tetr	.6	6.3,1.3	400,2x50		25w	15w
EC157	tri ampl	4.2	6.3,.73	180,60	43	12.5w	1.8w
EC158	tri ampl	4.2	6.3,.85	180,140	30	30w	5w
EC88	tri ampl	.9	6.3,.19	160,12.5	65	2.2w	
BRITISH INDUSTRIES CORP., 80 Shore Road, Port Washington, N.Y.							
A2521	tri	1	6.3,0.37	250,20	60	2.5w	
A2244	tri	3	6.3,0.4	350,150	30	10w	1w
A2327	tri	3	6.3,0.4	350,150	30	10w	1w
CV2204	tri	3	6.3,0.4	350,150	30	10w	1w
BRITISH INDUSTRIES CORP.—*(Continued)*							
DET22	tri	3	6.3,0.4	350,150	30	10w	4w
DET29	tri	6	6.3,0.4	450,120	55	10w	1.7w
DET24	tri	2	6.3,1	400,600	33	20w	10w
ACT22	tri	1	6.3,4	600,1.5a	22	75w	90w
ACT25	tri	1	13.5,2.8	1k,5a	75	400w	300w
ACT27	tri	0.6	15,6.7	1.5k,10a	45	1.5kw	1kw
COMPAGNIE FRANCAISE THOMSON-HOUSTON, 6, Rue Mario-Nikis, Paris							
TH6885	tri ampl	3	6.3,2.1	1.2k,50	80	250w	20w
TH6886	tri ampl,.0005	3	6.3,2.1	6k		250w	15kw
TH6942	tetr ampl	.9	5.7,24	4k,100	17	1.5kw	1kw
THF6001	tri ampl,.003	1	6.3,5	8k,150	20	450w	20kw
THF6002	tri ampl,.003	1	6.3,15	8k,400	20	1.2kw	60kw

ABBREVIATIONS AND NOTES

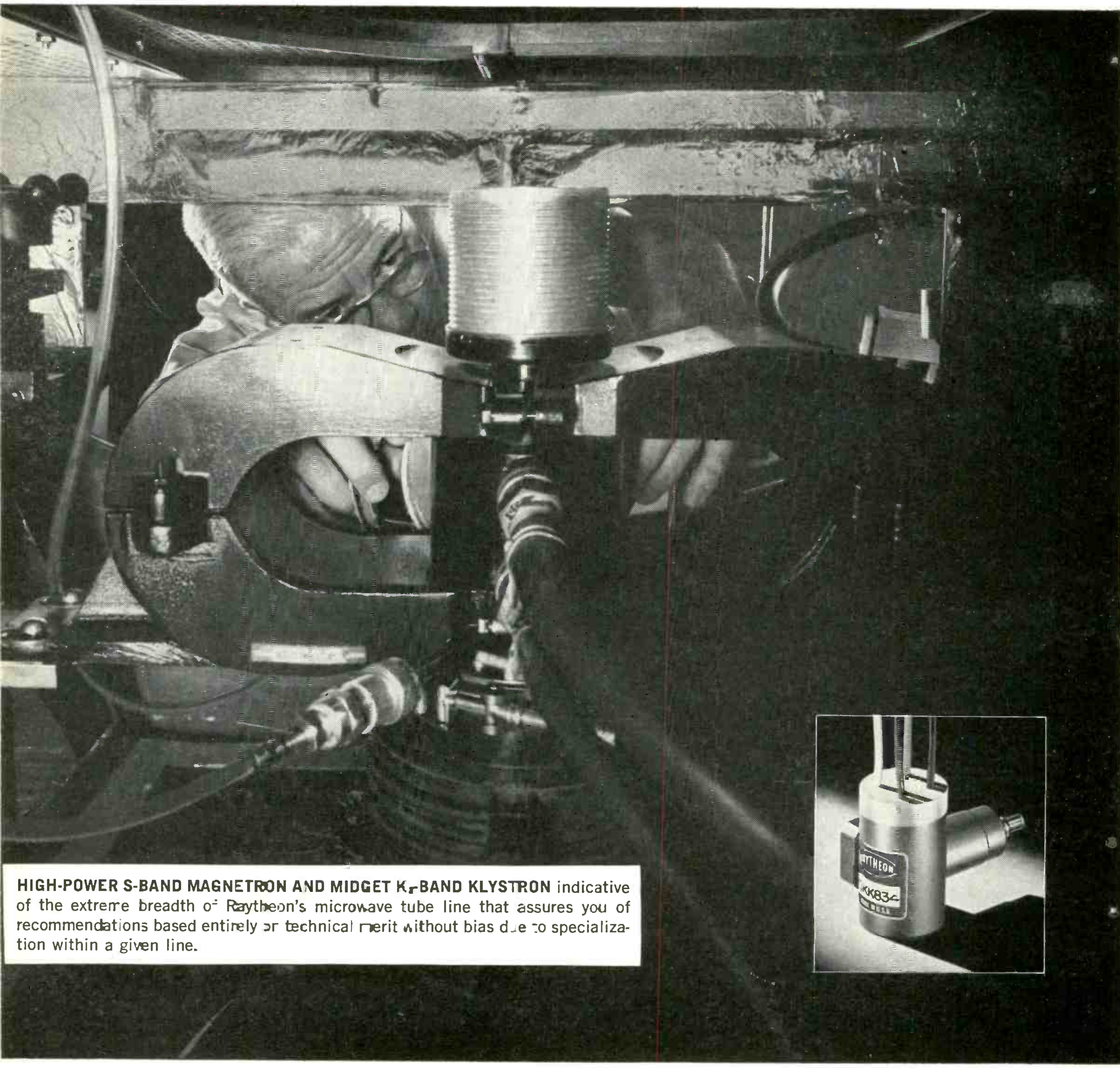
a—ampere
a/c—forced air cooled
ampl—amplifier
cav—cavity
cw—continuous wave
em—electromagnetic
es—electrostatic
fix—fixed frequency
gg—grounded grid
int—intermediate amplifier
k—thousand
megw—megawatt
min—miniature
mw—milliwatt
mod—modulator
mult—frequency multiplier; multi-resonator
osc—oscillator
p—peak
pkgd—packaged
plsd—pulsed
pm—permanent magnet
ppm—periodic permanent magnet
pwr—power
refl—reflex
res—resonator
rug—ruggedized
sol—solenoid
tetr—tetrode
t-d—tunnel diode
tri—triode
tun—tunable
v. tun—voltage tuned
w—watt
w/c—water cooled

Note 1: Velocity modulated oscillators are listed under Magnetrons.

Note 2: Pencil tubes and other coaxial tube types are listed under Planar Triodes and Tetrodes.

Quickly following up breakthroughs with good, sound, reproducible designs...

RAYTHEON LISTS 201*



HIGH-POWER S-BAND MAGNETRON AND MIDGET K_u-BAND KLYSTRON indicative of the extreme breadth of Raytheon's microwave tube line that assures you of recommendations based entirely on technical merit without bias due to specialization within a given line.

*Active unclassified types at date this advertisement was prepared, 5/1/61.

MICROWAVE TUBE TYPES

THIS TABLE summarizes currently available unclassified tubes. Many others, both classified and developmental, are available in all categories. Write for detailed information or tell us about your special requirement.

5 AMPLITRONS* AND STABILOTRONS—The AMPLITRON, invented and produced by Raytheon, is the most highly efficient microwave tube yet developed. In addition to the types covered in this table, over 20 classified Amplitrons and their related oscillators, Stabilotrons, are in development and production. Raytheon is also developing new models for relatively low powers and extending the line from UHF through the millimeter region.

BAND	FREQ. Mcs	CLASS	PEAK POWER	NO. TYPES
L	1265-1350	Stabilotron	550kw-5.28Mw	1
L	1250-1350	Amplitron	5.28-10Mw	2
S	2700-3100	Amplitron	3.0Mw	2

*Raytheon Trademark

75 MAGNETRONS—CW Tunable (CWT), Fixed Freq. Pulsed (FFP), Tunable Pulsed (TP), Tunable Pulsed—High Duty Cycle (TP-HDC), Hydraulically Tuned Pulsed (HTP).

BAND	FREQ. Mcs	CLASS	PEAK POWER	NO. TYPES
UHF	406-680	TP; FFP	2Mw	6
L	950-1350	CWT; FFP; TP	.19kW to 5Mw	8
S	2350-3570	CWT; FFP; TP	.050kW to 4.5Mw	25
C	4268-5600	FFP; TP	1w to 1Mw	12
X	8500-9460	TP; HTP; TP-HDC; FFP	.08kw to 1Mw	19
K	15,840-24,270	FFP	40 to 85kw	5

84 KLYSTRONS—External Cavity (EC), Communications (C), Local Oscillator (LO), Thermally Tuned (TT), High Frequency (HF), Millimeter (M), High Power Amplifier (HPA)

BAND	FREQ. Mcs	CLASS	PEAK POWER	NO. TYPES
L	1245-1460	LO; HPA	70mW to 2Mw	2
C	550-10,750	EC; LO; TT; C	20mW to 1.4W	28
X	7750-11,700	C; LO; EC; TT	30mW to 1.4W	13
K	11,700-120,000	C; HF; TT; M	25 to 700mW	41

27 "O" TYPE BACKWARD WAVE OSCILLATORS

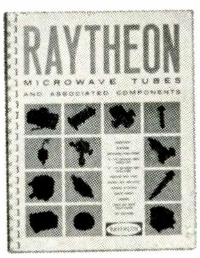
BAND	FREQ. kMc	POWER OUTPUT	NO. TYPES
L	1.0-2.0	100-1200mW	2
S	1.97-4.08	20-1000mW	7
C	3.6-8.0	20-700mW	8
X	6.7-12.4	10-300mW	8
Ke	12.4-18.0	15mW	1
Ku	18.0-26.5	15mW	1

3 "M" TYPE BACKWARD WAVE OSCILLATORS

BAND	FREQ. kMc	POWER OUTPUT	NO. TYPES
S	2.5-3.3	250-300W	1
C	3.25-4.45	250-300W	1
X	8.5-11.0	200 nom. W	1

7 TRAVELING WAVE TUBES AND CROSSED FIELD AMPLIFIERS

BAND	FREQ. Mcs	CLASS	POWER OUTPUT	NO. TYPES
S	—	CFA	300 W	1
C	2700-8000	TWT	1.0W-60kw	6



COMPREHENSIVE 72-PAGE CATALOG describes all tubes listed above and covers Raytheon complete microwave capability in tubes, magnetic components, ferrite devices and associated equipment. Write for your copy today to Raytheon Company, Microwave and Power Tube Division, Waltham 54, Massachusetts.

RAYTHEON COMPANY

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MICROWAVE AND POWER TUBE DIVISION

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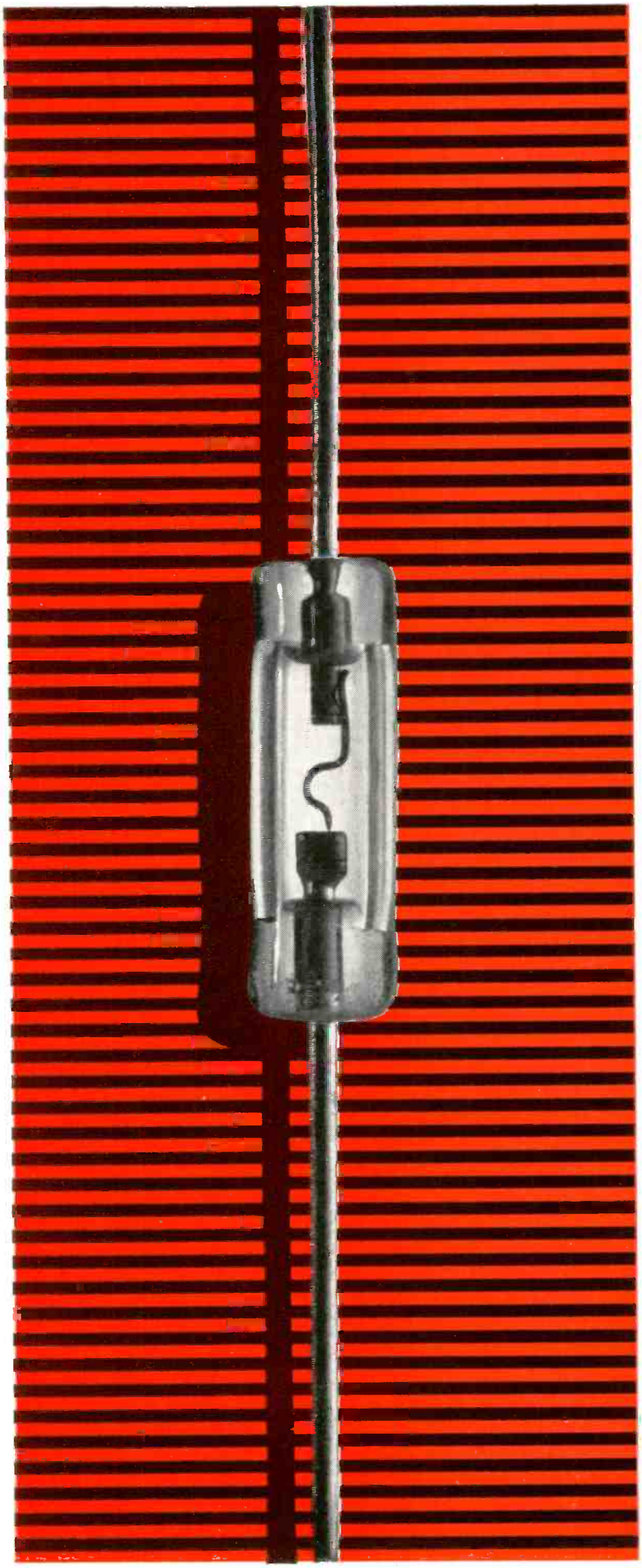
Circle 77 on Inquiry Card

PLANAR TRIODES AND TETRODES—*(Continued)*

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Anode V;MA	Ampl Fac	Max. Diss.	Power Output
CAMPAGNIE FRANCAISE THOMSON–HOUSTON—*(Continued)*							
THF6007	tri ampl	1	6.3,5	15k,150	70	600w	400w
THF6017	tetr ampl	.7	5,30	5k	15	12kw	10kw
THF6019	tri ampl	.6	6.3,10	3k,200	70	800w	1kw
ALLEN B. DUMONT LABS., 750 Bloomfield Ave., Clifton, N.J.							
6280/416B	tri ampl	4	6.3,1.18	200,30	200	7.5w	
7739	tri osc,.04	5	6.1,1.18	350,250		7.5w	
EITEL–McCULLOUGH, INC., San Carlos, Calif.							
2C39	tri ampl	2.5	6.3,1.1	800,80		100w	27w
2C39WA	tri ampl	2.5	6,1.05	800,80		100w	27w
3CPN10A5	tri ampl,.002	3	6,1.05	3.5k,3a		10w	1.6kw
3CX100A5	tri ampl	2.5	6,1.05	800,80		100w	27w
3X100A5	tri ampl	2.5	6.3,1.1	800,80		100w	27w
4X150G	tri ampl	1.5	2.5,7.3	7k ,6a		150w	17kwp
X685C	tri ampl	2.5	6,1.05	900,90		100w	15w
X779	tri ampl	2.5	26.5,0.225	900,90		100w	15w
L. M. ERICCSON, Stockholm 20, Sweden (State Labs., Inc., 215 Park Ave., South New York 3, N.Y.)							
416B	tri ampl	.2–4	6.3,1.18	270,33	300	7.5w	
GENERAL ELECTRIC CO., Power Tube Dept., Schenectady 5, N.Y.							
GL6283	tetr ampl,cw	.9	6.3,3.6	1.6k,.3		300w	154w
GL6848	tetr ampl,cw	.8	6.7,14.5	7k,1k		2kw	1.25kw
GL6942	tetr ampl,cw	.9	5.7,24	4k,700		1.5kw	1.2kw
GL7399	tetr ampl,.001	1.5	6.3,5.6	9k,9.2		300w	52kw
GL7985	tetr ampl,cw	.8	6.7,14.5	7k,1k		3.5kw	3.2kw
ZP1018	tetr ampl	1.6		2.5k,1.3k		100w	1.6kw
THE MACHLETT LABS., Springdale, Connecticut							
ML2C39A	tri ampl,cw	2.5	6.3,1	1k,125	100	100w	
ML2C41	tri ampl,.0025	3	6.3,1.03	3.5k,6.5k	100	35w	
ML3CPN10A5	tri ampl,.0025	3	6,1	3.5k,4.8k	100	10w	
ML3CX100A5	tri ampl,cw	2.5	6,1	1k,125	100	100w	
ML518	tri ampl,cw	2.5	6,1	600,125	100	100w	
ML6442	tri ampl,.001	5	6.3,.9	3k,3.75k	50	8w	
ML6771	tri ampl,cw	4	6.3,.57	300,33	90	6.25w	
ML7209	tri ampl,.0033	3	6,1	3.5k,4.5k	100	35w	
ML7210	tri ampl,cw	3	6.3,.85	1k,95	75	100w	
ML7211	tri ampl,cw	2.5	6.3,1.3	1k,190	80	100w	
ML7289	tri ampl,cw	2.5 6,1	6,1	1k,125	100	100w	
ML7698	tri ampl,.0025	3	6.3,1.3	3.5k,7.5k	80	10w	
ML7815	tri ampl,.0025	3	6,1	3.5k,4.8k	100	10w	
ML7855	tri ampl,cw	2.5	6,1	1k,125	80	100w	
NIPPON ELECTRIC CO., LTD., Tokyo, Japan							
2C39A,B*	tri ampl	2.5	6.3,1	900,90	100	100w	15w
2C40	tri ampl	3.37	6.3,.75	250,20	35	6.5w	85mw
2C43	tri ampl	3.37	6.3,.9	3k,2a	48	12w	1kwp
5861	tri ampl	3.7	6.3,.4	300,30	30	10w	.5w
2C46	tri ampl	1.3	6.3,.75	250,15	65	12w	
LD497	tri ampl	2.5	6.3,.3	900,140	90	140w	26w
LD583*	tri ampl	2.5	6.3,1.3	900,140	90	140w	26w
* *Ceramic sealed*							
NIPPON ELECTRIC CO.—*(Continued)*							
LD509*	tri ampl	2.5	6.3,1.3	1.25k,150	90	230w	50w
LD531*	tri ampl	2.2	6.3,2.3	1.7k,350	130	550w	100w
LD551*	tri ampl	2	6.3,4	3k,700	130	2kw	300w
**Ceramic sealed*							
RADIO CORPORATION OF AMERICA, Electron Tube Div., Harrison, N.J.							
5671*	tri osc	3	6.3,.135	165,30	20	5w	.475w
5876*	tri osc	1.7	6.3,.135	360,25	56	6.25w	3w
5893*	tri osc,ampl	3.3	6,.28	320,35	27	7.5w	5w
6263*	tri osc,ampl	1.7	6,.28	330,40	27	8w	7w
7552*	tri ampl	1	6.3,.225	250,25	80	2.5w	13db
7553*	tri ampl	1	6.3,.225	250,25	80	2.5w	14db
7554*	tri ampl	3	6.3,.225	300,25	70	2.5w	1.6w
A15205*	tri osc,plsd	3.3	6.3,.225	1.25k,2k	70	2.5w	250w
6562*	tri osc	1.68	6,.16	120,34		3.6w	.5w
7533*	tri osc	1.68	6,.16	130,34		3.6w	.575w
A15131*	tri osc	.975–1.225	6,.135	165,38		5w	.3w
A15132*	tri osc,plsd	.975–1.225	6,.28	1.75k,3k		6w	500w
A15219*	tri osc	.9–1.05	6.3,.135	250,30		5w	1.5w
A15220*	tri osc,plsd	.9–1.05	6,.28	1.75k,3k		6w	800w
A15221*	tri osc	1–1.3	6.3,.135	250,30		5w	1w
A15222*	tri osc,plsd	1–1.3	6,.28	1.75k,3k		6w	600w
A15223*	tri osc	1.25–1.6	6.3,.135	250,30		5w	.8w
A15224*	tri osc,plsd	1.25–1.6	6,.28	1.75k,3k		6w	500w
A15225*	tri osc	1.55–1.9	6.3,.135	250,30		5w	.6w
A15226*	tri osc,plsd	1.55–1.9	6,.28	1.75k,3k		6w	400w
A15227*	tri osc	1.85–2.2	6.3,.225	250,30		2.5w	.3w
A15228*	tri osc,plsd	1.85–2.2	6,.28	1.75k,3k		6w	300w
A15229*	tri osc	2.15–2.5	6.3,.225	250,30		2.5w	.2w
A15230*	tri osc,plsd	2.15–2.5	6,28	1.75k,3k		6w	200w
A15231*	tri osc	2.45–2.8	6.3,.225	250,30		2.5w	.15w
A15232*	tri osc,plsd	2.45–2.8	6,.28	1.75k,3k		6w	150w
A15233*	tri osc	2.75–3.1	6.3,.225	250,30		2.5w	.1w
A15234*	tri osc,plsd	2.75–3.1	6,.28	1.75k,3k		6w	100w
A15235*	tri osc	3.05–3.4	6.3,.225	250,30		2.5w	.05w
A15236*	tri osc,plsd	3.05–3.4	6..28	1.75k,3k		6w	50w
SS100**	t-d osc			.2,40			.3mw
SS104**	t-d osc	.8–1.4		.2,35			.3mw
SS107**	t-d osc	.5–2		.4,160			1mw
**Coaxial pencil-type construction.* ***Solid-state osc.*							
STANDARD TELEPHONES & CABLES, LTD., Brixham Rd., Paignton, Devon							
2C39A	tri ampl	2.5	6.3,1	1k,125	100	100w	27w
3B/106J	tri ampl,plsd	2.5	6.3,1	3.5k,2k	100	10w	2.4kw
SYLVANIA, Special Tube Operations, 1891 E. Third St., Williamsport, Pa.							
2C36	plsd osc	3	6.3,.4	1.2k,0.9	25	5w	200w
2C37	cw osc	3.3	6.3,.4	200,.025	25	5w	450mw
5764	cw osc	3.3	6.3,.425	200,.025	25	5w	450mw
5765	cw osc	2.9	6.3,.4	180,.025	25	5w	250mw
5768	gg ampl	3	6.3,.4	150,.007	90	2w	10db gain
6481	cw osc	3.3	6.3,.4	180,.016	25	5w	500mw
6503	cw osc	3.3	6.3,.4	200,.025	23	5w	450mw
5767	cw osc	3.3	6.3,.4	200,.025	25	5w	450mw

KLYSTRONS

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L.I., N.Y.							
2K25	refl	8.5–9.66	6.3,.44	300,.025	200	35mc	25mw
DX184	refl	31–36	6.3,8	2.25k,.015	300	60mc	100mw
DX151	refl	67–73	3.5,1.8	2.5k,.017	300	100mc	100mw
BENDIX, Red Bank Div., Eatontown, N. J.							
TK4	refl	23.5–24.5	6.3	330,.01	150		10mw
TK37	refl	34–35.6	6.3	425,.04	400		10mw
TK38	refl	5.1–5.9	6.3	330,.035	300		70mw
TK53	refl	34–35.6	6.3	400,.029	110		10mw
TK58	refl	8.5–9.66	6.3	300,.032	145		20mw
TK59	refl	8.5–9.66	6.3	300,.032	145		20mw
TK60	refl	23.25–24.75	6.3	330,.03	300		10mw
TK61	refl	10.525	6.3	300,.032	145		20mw
TK62	refl	8.5–9.6	6.3	300,.036	145		20mw
TK68	refl	5.12–5.43	6.3	300,.032	160		80mw
TK69	refl	5.1–5.9	6.3	330,.035	300		70mw
TK78	refl	34–35.6	6.3	425,.04	400		10mw
TK84	refl	16–17		300,.025	180		20mw
TK90	refl	8.5–9.66		300,.025	150		30mw
TK91	refl	8.5–9.66		300,.025	125		30mw
TK92	refl	8.5–9.66		300,.028	145		20mw
TK96	refl	5.35–5.95	6.3	300,.032			20mw
TK97	refl	8.5–9.6	6.3	300,.028			20mw
BOMAC LABORATORIES, INC., Salem Rd., Beverly, Mass.							
BL801	tun	8.5–9.6		300			30mw
BL800A	tun	8.5–10		200			20mw
BL803	tun	8.5–10		200			20mw
BL800	tun	8.5–10		200			25mw
BL811	fix	8.5–10		210			25mw
6310	tun	8.5–10		300			70mw
6312	tun	8.5–10		300			70mw
BL806	tun	8.5–10		500			0.3w
BL825	tun	8.5–10		500			0.5w
BOMAC LABORATORIES, INC.—*(Continued)*							
BL807	tun	8.5–10.5		350			120mw
BL818	tun	8.5–10.5		350			120mw
BL830	tun	8.69–8.79		250			15mw
BL815	fix	9.142–9.152		200			30mw
BL831	fix	9.26		300			80mw
BL832	fix	9.34		300			80mw
BL814	tun	10.4–12.3		400			0.2w
BL812	tun	8.5–9.6		300			60mw
BL829	fix	8–9.5		500			0.5w
BL802	tun	8.8–9.2		250			30mw
BL819	tun	9–9.2		300			60mw
BL820	tun	9.05–9.25		300			60mw
BL824	tun	9.2–9.5		300			60mw
BL841	fix	8–9.5		300			60mw
BL843	fix	8–9.5		200			20mw
BRITISH INDUSTRIES CORP., 80 Shore Road, Port Washington, N.Y.							
KLX1	4 cav	4.1,4.8	4.1,4.8	11k,0.3		±30mc	1130w
KLS2	3 cav	5,9.5	5,9.5	10k,1		±50mc	1.7kw
COMPAGNIE FRANCAISE THOMSON–HOUSTON, 6, Rue Mario-Nikis, Paris							
TH2010	ampl	2.925–2.975	25,25	260k,210		20mc	20kw
TH2011A	ampl	2.9–3	25,25	230k,220		60mc	12kw
TH2011B	ampl	3–3.1	25,25	230k,220		60mc	12kw
TH2012A	ampl	2.9–3	25,25	140k,100		60mc	10kw
TH2012B	ampl	3–3.1	25,25	140k,100		60mc	10kw
TH2013	ampl	2.95–3.05	25,25	350k,210		20mc	5kw
TH2014	ampl	2.95–3.06	25,25	160k,105		30mc	5kw
TH2015	ampl	2.95–3.06	25,25	250k,250		30mc	15kw
TH2101	ampl	2.9–3.1	6.3,5	24k,9		60mc	.1kw
TH6975	refl	8.5–9.6	6.3,.45	350,.052	500		20mw
TH2K25A	refl	8.5–9.6	6.3,.47	330,.032	400		20mw
TH6116	refl	8.5–9.6	6.3,.5	500,.055	145		20mw
TH2058	refl	8.5–10	6.3,1.2	330,.032	1k		500mw
TH2K29	refl	3.4–3.96	6.3,.47	300,.04	250		85mw



FASTEST SWITCHING SPEED
HIGHEST CONDUCTANCE
LOWEST JUNCTION CAPACITANCE

MA-4121 silicon point-contact diodes will work in 200 Mc computers

THEY'RE ALREADY AT WORK IN 100 Mc COMPUTERS

MA-4121 computer diodes have the desired combination of parameters for use in the very fastest switching circuits.

Fractional nanosecond switching* — **typically 0.5 nsec.**

High forward conductance — **30 mA at 1.0 V (max.)**
10 mA at 0.55 V (max.)

Low junction capacitance — **0.5 pf (max.) at zero volts bias.**

They are hermetically sealed in an all-glass package with no soldered end seals, insuring no loss of hermeticity during circuit assembly.

Two years ago Microwave Associates introduced the first 4 nanosecond switching diodes on a commercial basis (1N903 series). They were rapidly adopted as industry standards.

Today the MA-4121 enables you to design computer circuits with almost an order of magnitude increase in speed. This diode is ideal for coincidence circuits, pulse circuits, ultra-high-speed switching, and all types of logic functions.

There is no substitute for capability. There is no substitute for quality. Microwave Associates computer diode technology has proven itself on both counts. We'd like to put our experience to work for you.

***Actual recovery time is so fast that the observed time in a sampling or traveling wave oscilloscope is primarily determined by the wiring configuration.**

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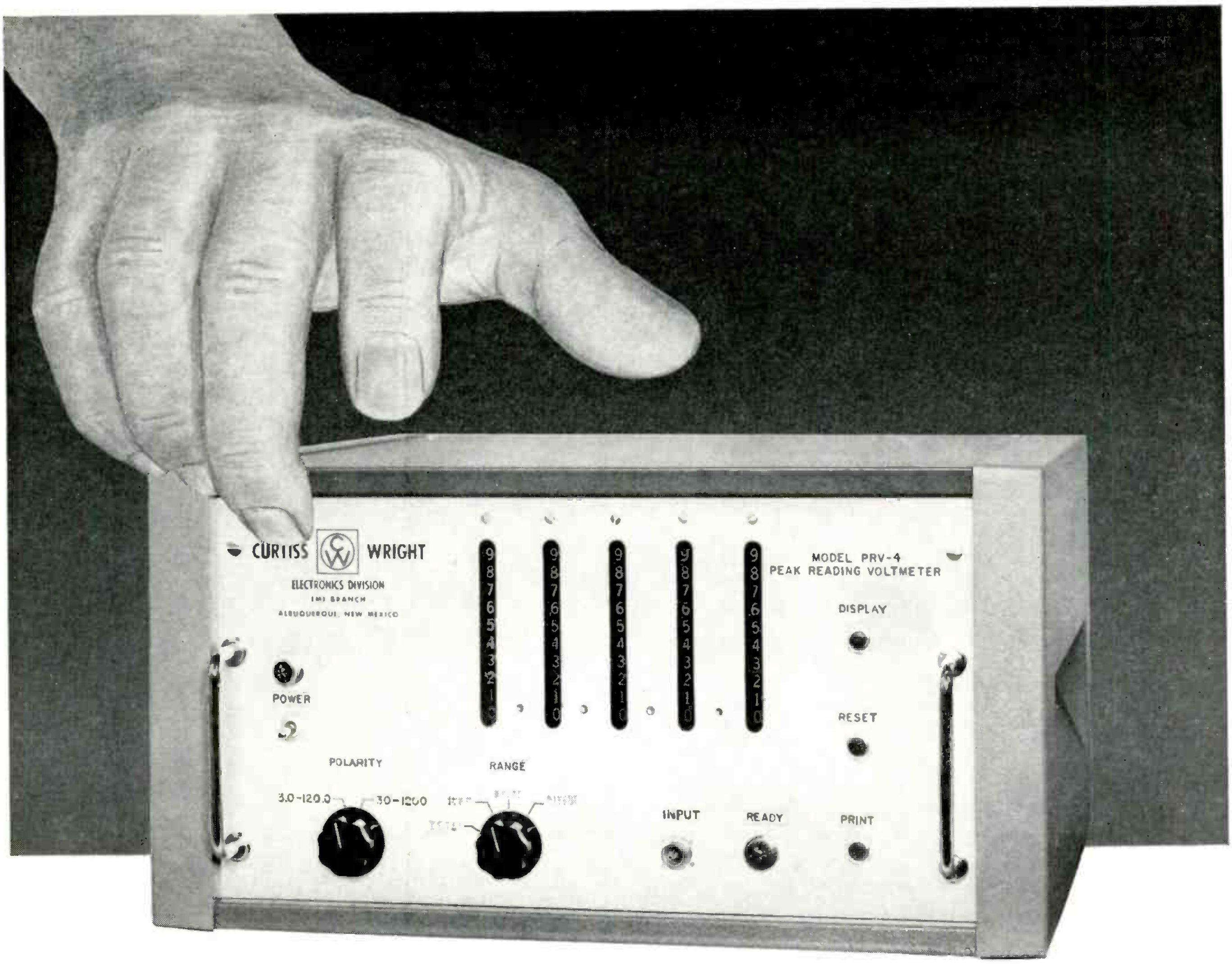
Circle 86 on Inquiry Card

KLYSTRONS — *(Continued)*

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
COMPAGNIE FRANCAISE THOMSON-HOUSTON—*(Continued)*							
TH2K28	refl	1.2–4	6.3,.47	300,.032	300		80mw
TH726A	refl	3.173–3.407	6.3,.47	330,.032	250		85mw
TH726B	refl	2.884–3.173	6.3,.47	330,.032	250		85mw
TH726C	refl	2.7–2.96	6.3,.47	330,.032	250		85mw
TH2220A	refl	7.45–7.75	6.3,.8	750,.08	1k		.7w
TH2220B	refl	7.125–7.425	6.3,.8	750,.08	1k		.7w
TH2220C	refl	6.875–7.125	6.3,.8	750,.08	1k		.7w
TH2220D	refl	6.575–6.875	6.3,.8	750,.08	1k		.7w
TH2220E	refl	6.125–6.425	6.3,.8	750,.08	1k		.7w
TH2220F	refl	5,925–6.225	6.3,.8	750,.08	1k		.7w
TH2220G	refl	6.425–6.575	6.3,.8	750,.08	1k		.7w
TH2220J	refl	4.9–5.2	6.3,.8	750,.08	1k		.7w
TH2412	refl	5.1–5.9	6.3,.44	350,.035	350		
COMPAGNIE GENERALE DE T.S.F., 79 Boulevard Haussman, Paris 8, France							
6BL6	osc	1.6–6.5	6.3,.68	325,.028	140		.2w
5836	osc	1.6–6.5	6.3,.68	325,.025	140		.2w
6BM6	osc	.5–3.8	6.3,.68	325,.018	500		.1w
KR117	osc	2.75–3.65	6.3,1	450,.028	210		.38w
KR142B	osc	2.75–3.65	6.3,2.4	400,.052	180		.17w
KR740	osc	2.9–3.5	6.3,1	1000,.085	570		3w
KR741	osc	3.45–3.75	6.3,1	850,.067	325		1.7w
KR742	osc	3.75–4	6.3,1	850,.067	330		1.7w
KR743	osc	4–4.25	6.3–1	850,.067	310		1.65w
AK435	ampl,.0015	3		130k,130			6megw
AK436	ampl,.0002	3		240k,240			25megw
KP334	ampl	3		40k,15			40kw
EITEL-McCULLOUGH, INC., San Carlos, Calif.							
1K20XS	refl osc	8.5–9.2	6.3,1	350,.055	150		75mw
1K20XK	refl osc	9.2–10	6.3,1	350,.050	150		75mw
1K20XD	refl osc	10–10.7	6.3,1	350,.055	150		75mw
1K015CA	refl osc	5.35–5.95	6.3,1	350,.049	240		130mw
1K015CG	refl osc	5.35–5.95	6.3,1	350,.049	240		130mw
1K75CH	refl osc	4.3 ±50mc	6.3,1.5	750,.060	350		1w
1K75CK	refl osc	4.3 ±50mc	6.3,1.5	750,.060	350		1w
1K125CA	refl osc	3.7–4.4	6.3,1.5	1k,.075	275		1.6w
1K125CB	refl osc	4.4–5	6.3,1.5	1k,.075	345		2.5w
3K2500LX	3 cav ampl	9.8–1.2	7.5,5.8	7k,0.455			1.32kw
3K2500SG	3 cav ampl	1.7–2.4	7.5,5.8	7k,0.57			1.3kw
3K3000LQ	3 cav ampl	0.61–0.985	5,32	9k,0.6			2.4kw
3K50000LA	3 cav ampl	0.4–0.6	8,40	15k,1.65			10.7kw
3K50000LF	3 cav ampl	0.57–0.72	8,40	15k,1.65			10.7kw
3K50000LQ	3 cav ampl	0.72–0.985	8,40	15k,1.65			10.7kw
3KM3000LA	3 cav ampl	0.385–0.585	5,32	9k,0.59			2.3kw
3KM4000LT	3 cav ampl	0.96–1.215	7.5,5.5	26k,0.133			38.2kw
3KM50000PA	3 cav ampl	0.225–0.4	7.5,40	23k,2.6			23.1kw
4K50000LQ	4 cav ampl	0.6–0.985	8,40	16k,1.59			11.2kw
4KM3000LQ	ampl	0.71–0.985	5,33	9k,0.58			2.15kw
4KM3000LR	ampl	0.61–0.985	5,31	8.5k,0.55			2.1kw
4KM50000LA	ampl	0.4–0.63	7.5,40	17k,1.8			10kw
4KM50000LQ	4 cav ampl	0.61–0.985	7.5,40	17k,1.8			10kw
4KM50000SG	4 cav ampl	1.7–2.4	6.3,37.5	17k,1.9			12kw
4KM170000LA	4 cav ampl	0.3–0.5	11,47.5	33k,4.8			77kw
4KMP10000LF	4 cav ampl	0.57–0.63	12,25	61.5k,0.15			400kwp
6K50000LQ	4 cav ampl	0.72–0.98	8,40	19.5k,2.3			9kw
X626	3 cav ampl	0.4–0.45	7.5,95	105k,2.07			1.25megw
X602K	4 cav ampl	0.375–0.5	11,47.5	45k,1.69			155kw
X632	ampl,0.167	2.845–2.865	11,25	235k,105			10megw
X700	4 cav ampl	2.4–2.9	7.5,5.5	21k,0.138			20kw
X563K.L,M	ampl	5.4–7.1	6.3,1	3k,0.13			60kw
X768	3 cav ampl	0.755–0.985					75kw
X821	refl	10.5–13.2	6.3,1	750,.1	350		1w
EMI ELECTRONICS, LTD., Hayes, Middlesex, England							
R9604	refl	36.6–46.1	6.3,.8	2k,.012	300	60mc	60mw
R9555	refl	37.5–43	6.3,.8	2k,.012	300	60mc	60mw
R9521	refl	35–40	6.3,.8	2k,.012	300	60mc	40mw
R9546	refl	32–37.5	6.3,.8	2k,.012	300	60mc	40mw
R5146	refl	34–36.5	6.3,.8	2k,.01	300	60mc	60mw
R9518	refl	27.8–32.2	6.3,.8	2k,.012	300	60mc	60mw
R9547	refl	24–27.8	6.3,.8	2k,.012	300	60mc	60mw
R9602	refl	22–26	6.3,.8	2k,.012	300	60mc	60mw
R9621	refl	20–24	6.3,.8	2k,.012	300	60mc	60mw
R9622	refl	18–22.5	6.3,.8	2k,.012	300	60mc	60mw
25182	refl	8.2–11.7	6.3,.7	350,.04	350	20mc	20mw
25157	refl	7–10.3	6.3,.7	350,.04	270	20mc	20mw
25181	refl	5.4–8.2	6.3,.7	350,.04	300	20mc	20mw
25181A	refl	5–5.9	6.3,1.2	350,.04	250	20mc	20mw
R5222	refl	5–11.7	6.3,.7	350,.04	500		
R9538	refl	9.1–9.3	6.3,1.2	350,.04	210	20mc	20mw
R9539	refl	9.3–9.5	6.3,1.2	350,.04	220	20mc	20mw
R9540	refl	9.5–9.7	6.3,1.2	350,.04	230	20mc	20mw
R9541	refl	9.7–9.9	6.3,1.2	350,.04	240	20mc	60mw
R9542	refl	9.9–10.1	6.3,1.2	350,.04	250	20mc	60mw
R9543	refl	10.1–10.6	6.3,1.2	350,.04	260	20mc	60mw
R9544	refl	10.6–11	6.3,1.2	350,.04	300	20mc	45mw
KRN3	refl	9.55–9.9	4,1.3	1.35k,.008	250	25mc	25mw
R9516	refl	7.05–7.3	12.6,1.1	1k,.12	300	60mc	2.2w
R9599	refl	3.95–5.5	6.3,1.2	350,.035	500	25mc	80mw
R6010	refl	4.4–4.8	6.3,.9	750,.143	290	50mc	3.7w
R6015	refl	4.27–4.6	6.3,.9	250,.04	175	20mc	150mw
25221	refl	3.3–4.9	6.3,1.2	350,.035	400	25mc	80mw
R5081	refl	3,9–4.2	6.3,.9	750,.143	350	40mc	4w
RK6112	refl	1–4	6.3,.7	250,.026	400		150mw
R9559	refl	1–5.4	6.3,1.2	300,.035	400		100mw
R9585	refl	.5–3	6.3,.7	300,.02	400		50mw

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
EMI ELECTRONICS, LTD.—*(Continued)*							
25205	refl	3.28–3.72	6.3,1.2	300,.035	200	30mc	120mw
KR6/1	refl	3.36–3.55	4,1.3	250,.032	140	30mc	150mw
KR6/2	refl	3.17–3.39	4,1.3	250,.032	140	30mc	150mw
KR6/3	refl	2,93–3.13	4,1.3	250,.032	140	30mc	150mw
R9570	ampl,.0012	2.7–3.05	9–11,6.5–8	50k,.011		5mc	100kw
R9571	ampl,.0034	2.7–3.05	9–11,6.5–8	25k,8.8		30mc	15kw
KLXI	ampl	9–9.6	4.1,4.8	11k,.05		50mc	11kw
VX5023	refl	Q-band	6.3,0.8	2k,.015	500		60mw
ENGLISH ELECTRIC VALVE CO., LTD., Chelmsford, England							
4KM5000LA	ampl,cw	.4–.61	7.5,40	16k,1.5	200		10kw
K300	refl	9.32–9.5	6.3,.6	350,.035	140	30mc	30mw
K301	refl	2.5–3.5	6.3,.6	350,.035	375	15mc	30mw
K302	refl	9.32–9.5	6.3,.6	350,.035	155	30mc	30mw
K305	refl	9.25–9.5	6.3,.6	350,.035	160	35mc	25mw
K308	refl	8.8–8.9	6.3,.6	350,.035	210	40mc	40mw
K311	refl	8.5–9.5	6.3,.6	350,.035	355	30mc	45mw
K312	refl	9.43–9.65	6.3,.6	350,.035	170	30mc	30mw
K313	refl	9.645–9.775	6.3,.6	350,.035	175	30mc	25mw
K315	refl	9.105–9.205	6.3,.6	350,.035	260	30mc	20mw
K317	refl	8.2–8.3	6.3,.6	350,.035	310	30mc	20mw
K321	refl	9.43–9.65	6.3,.6	350,.035	170	30mc	25mw
K323	refl	9.645–9.775	6.3,.6	350,.035	175	30mc	25mw
K324	refl	9–10	6.3,.6	350,.035	390	30mc	45mw
K328	refl	9.555–9.685	6.3,.6	350,.035	180	30mc	25mw
K335	refl	9.555–9.685	6.3,.6	350,.035	170	30mc	25mw
K337	refl	9–10	6.3,.6	350,.035	390	24mc	45mw
K340	refl	9.3–9.5	6.3,.6	300,.025	165	40mc	35mw
K342	refl	8.5–9	6.3,.6	350,.035	265	35mc	45mw
K343	refl	12–14.5	6.3,.6	350,.03	220	50mc	50mw
K345	refl	5.925–7.725	6.3,.8	750,.072	350	30mc	1w
K346	refl	14.5–17	6.3,.6	350,.03	180	75mc	45mw
K347	ampl,.0024	.58–.615	7,35	78k,10			600kw
K350	osc	8.5–10	6.3,1.7	700,.07		12mc	1.2w
K351	refl	8.5–9.6	6.3,1.2	300,.04		42mc	30mw
K352	ampl,.0015	2.998	4.3,83	190k,140			6megw
K353	refl	10.5–12.2	6.3,1.2	400,.06		60mc	250mw
K357	refl	10.66–10.72	6.3,.6	250,.015	100	30mc	12mw
K358	refl	10.5–12.2	6.3,1.2	400,.06	250	60mc	250mw
K359	refl	8.1–8.75	6.3,1.2	350,.045	150	55mc	90mw
K361	refl	10.7–10.725	6.3,.6	300,.025	200	20mc	27mw
K347A	ampl,.0024	.58–.615	7,35	75k,10			600kw
L. M. ERICCSON, Stockholm 20, Sweden (State Labs Inc., 215 Park Ave., South New York 3, N.Y.)							
6811	refl osc	2.5–5	6.3,.6	825,.1-	700	.1mc/v	.1w
6812	refl osc	2.5–5	6.3,.6	350,.03	100	.1mc/v	.1w
GEISLER LABS., P.O. Box 353, Woodland Hills, Calif.							
GK70	refl	26.5–31.5	6.3,.7	2k,.03	300		100mw
G096	V tun osc	26–40	6.3,.6	1.5k,.04		15mc/v	20mw
LITTON INDUSTRIES, Electron Tube Div., San Carlos, Calif.							
L3270	ampl,.002	1.25–1.35		115k,93			2megw
L3303	ampl,.002	1.25–1.35		145k,139			5megw
L3323	ampl,.002	1.25–1.35		170k,174			10megw
L3428	ampl,.004	S-band					
LT7504	ampl,.003	1.24–1.36		115k,78			2.2megw
L3227	ampl,.002	1.25–1.35		150k,112			5megw
L3250	ampl,.0015	1.25–1.35		185k,160			10megw
L3355	ampl,.0015	1.25–1.35		230k,220			20megw
L3257	ampl,.00033	1.25–1.35		143k,110			4megw
L3387	ampl,.003	1.25–1.35		270k,280			30megw
L3401	ampl,.06	1.254–1.386		120k,120			5megw
L3486	ampl,.068	1.25–1.38		45k,18.5			.25megw
L3531	ampl,.0033	1.25–1.35		240k,290			25megw
L3403	ampl,.06	.4–.45		110k,110			1.25megw
L3302	ampl,.0015	2.855		185k,160			10megw
L3530	ampl,.0033	1.25–1.35		240K,290			25megw
L3495	ampl,.002	2.855		95k,63			2megw
L3617	ampl,.003	2,855		132k,105			5megw
L3618	ampl,.002	2.855		230k,239			20megw
L3628*	osc,cw	33–37					10w
L3629*	osc,cw	33–37					15w
L3630*	osc,cw	21–25					10w
L3631*	osc,cw	21–25					8w
L3632*	refl	34.5–35.5					30mw
L3633*	refl	34.5–35.5					250mw
METCOM, INC., 76 Lafayette St., Salem, Mass.							
MXK14	refl	8.5–10	6.3	300	250	30mc	40mw
MXK15	refl	8.5–10	6.3	300	250	30mc	40mw
MXK16	refl	8.5–10	6.3	300	250	30mc	40mw
MXK17	refl	8.5–10	6.3	250	120		30mw
MXK18	refl	8.5–10	6.3	300	250	30mc	35mw
MXK11	refl	8.5–10	6.3	300	200	20mc	40mw
MXK10	refl	8.5–9.6		300	250		30mw
MXK12	refl	8.5–10		300	200		40mw
MXK19	refl	8.5–10	6.3	310	200	30mc	35mw
MXK20	refl	11k	6.3	300	200	30mc	40mw
MXK22	refl	10–10.25	6.3	500	225	30mc	100mw
MXK23	refl	8.5–9.5		300	150		15mw
MXK24	refl	8.5–10.5	6.3	300	225	30mc	50mw
MXK25	refl	8.5–10.5		350	300		120mw
MXK26	refl	8.1–12.4		500	1k		100mw
MKK10	refl	18.132k–18.332k		700	400		100mw
MKK11	refl	13.295k–13.350k		3k			15w

*Elliott-Litton Ltd., types, available through Litton Industries



Capture...then Read

THE FIRST PEAK OF ANY VOLTAGE

Single Transient Peak Reading Voltmeter

FOR: Blast Studies — Shock Studies — Transient Voltage Measurements on Aircraft Power Busses — Measurement of any single transient phenomena which may be characterized by a voltage pulse.

The Model PRV-4 Single Transient Peak Reading Voltmeter is designed to accept and display the first value of a *positive* or *negative* voltage pulse of arbitrary shape within specified limits. Readout is provided as a four digit decimal value directly in volts with a fifth digit for over-range indication. First peak voltage detected blocks further input values until reset. A four line 1-2-2-4 coded output line is provided for external printout. The PRV-4 will read out peak amplitude of rectangular pulses of one microsecond or greater pulse width. Readout cycle time, 1 millisecond with accuracy of 0.5% of absolute or 10 counts. Range 30 MV. to 1000 V.

Write to Intermountain Branch for complete specifications on the PRV-4 and other models, or for information on custom units available for unique requirements.

ELECTRONICS DIVISION INTERMOUNTAIN BRANCH

CURTISS-WRIGHT CORPORATION

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MICROWAVE ELECTRON DEVICES

KLYSTRONS—*(Continued)*

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
NIPPON ELECTRIC CO., LTD., Tokyo, Japan							
2K25	refl	8.5–9.66	6.3,.44	300,.025	180	40mc	35mw
2K26	refl	6.25–7.06	6.3,.44	300,.025	115	50mc	100mw
2K54A	refl	4.05–4.3	6.3,.45	400,.025	350		500mw
2K54B	refl	3.85–4.1	6.3,.45	400,.025	350		500mw
2K54C	refl	3.65–3.9	6.3,.45	400,.025	350		500mw
2K54DA	refl	4.25–4.35	6.3,.45	250,.012	160	35mc	50mw
5976	refl	6.25–7.425	6.3,.44	300,.025	100	60mc	120mw
5721	refl	4–11	6.3,.58	1k,.02	150		100mw
4V27	refl	3.5–4.5	6.3,.675	325,.025	180		150mw
6V200	refl	6.225–6.325	6.3,.76	750,.07	130	50mc	300mw
6V201	refl	5.925–6.225	6.3,.76	750,.07	330	35mc	1.2w
6V202	refl	6.125–6.425	6.3,.76	750,.07	330	35mc	1.2w
6V203	refl	6.425–6.575	6.3,.76	750,.07	330	35mc	1.2w
7V204	refl	6.575–6.875	6.3,.76	750,.07	330	35mc	1.2w
7V205	refl	6.875–7.125	6.3,.76	750,.07	330	35mc	1.2w
7V206	refl	7.125–7.425	6.3,.76	750,.07	330	35mc	1.2w
8V207	refl	7.425–7.750	6.3,.76	750,.07	330	28mc	1w
8V208	refl	7.750–8.1	6.3,.76	750,.07	330	23mc	1w
6V211	refl	5.985–6.285	6.3,.44	300,.023	100	40mc	35mw
6V212	refl	6.285–6.585	6.3,.44	300,.023	100	40mc	35mw
1V213	refl	6.585–6.705	6.3,.44	300,.023	100	40mc	35mw
7V214	refl	6.705–7.005	6.3,.44	300,.023	100	40mc	40mw
7V215	refl	6.955–7.255	6.3,.44	300,.023	100	40mc	40mw
7V216	refl	7.255–7.555	6.3,.44	300,.023	100	40mc	40mw
8V217	refl	7.55–7.850	6.3,.44	300,.023	100	40mc	40mw
6V221	refl	5.925–6.225	6.3,.76	750,.07	330	35mc	1.2w
6V222	refl	6.125–6.425	6.3,.76	750,.07	330	35mc	1.2w
7V223	refl	6.425–6.575	6.3,.76	750,.07	330	35mc	1.2w
7V224	refl	6.575–6.875	6.3,.76	750,.07	330	35mc	1.2w
7V225	refl	6.875–7. 125	6.3,.76	750,.07	330	35mc	1.2w
7V226	refl	7.125–7.425	6.3,.76	750,.07	330	35mc	1.2w
8V227	refl	7.425–7.750	6.3,.76	750,.07	330	35mc	1w
8V228	refl	7.750–8.1	6.3,.76	750,.07	330	35mc	1w
11V53	refl	10.7–11.7	6.3,1.1	300,.028	180	40mc	70mw
11V53A	refl	10.7–11.7	6.3,1.1	450,.05	260	50mc	250mw
Z239/1G	refl	3.65–4.2	6.3,1	1.1k,.06	180	40mc	1.2w
V239/1K	refl	3.78–4.04	6.3,.25	300,.035			500mw
V241C/1K	refl	4–4.24	6.3,.25	300,.035			500mw
6V26AM	refl	6.1–6.5	6.3,.44	300,.025	110	60mc	120mw
8V69	refl	7.350–7.85	6.3,.44	300,.025	110	50mc	80mw
11V54	refl	10.7–11.7	6.3,.45	300,.028	180	40mc	70mw
11V55	refl	10.7–11.7	6.3,.45	500,.065	260	55mc	450mw
8V77	refl	7.65–8.2	6.3,.44	300,.025	130	30mc	60mw
11V54A	refl	10.7–11.7	6.3,.45	450,.05	260	50mc	250mw
LD561	refl	11.7–12.44	6.3,.45	400,.045	220	48mc	160mw
POLARAD ELECTRONICS CORP., 43-20 34th St., Long Island City 1, N.Y.							
ZV1011	refl, cw	4–11	6.3,.57	1.25k,.022	800	20mc	20mw
ZV1010X	refl, cw	.95–2.8	6.3,1.1	500,.06	700	6mc	200mw
ZV1021X	refl, cw	1–4	6.3,1.1	500,.06	700	6mc	200mw
ZV1009X	refl, cw	1.7–5	6.3,1.1	500,.06	700	6mc	200mw
ZV1012	refl, cw	.5–3	6.3,.68	350,.035	700	6mc	50mw
ZV1010	refl, cw	.7–3	6.3,.68	350,.035	700	6mc	50mw
ZV1009	refl, cw	1.5–6	6.3,.68	350,.035	700	6mc	50mw
RAYTHEON CO., Microwave & Power Tube Operations, Waltham, Mass.							
5837	osc	0.55–3.8		325	235	12	160mw
RK5777	osc	0.6–2.35		400	625	8	160mw
2K28A	osc	1.5–3.75		300	277	20	140mw
RK5778	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
2K29	osc	3.4–3.96		300	180	28	106mw
2K56	osc	3.84–4.46		300	150	30	100mw
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
QK549	osc	5.925–6.45		300	275	20	120mw
5976	osc	6.2–7.425		300	158	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
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
QK448	osc	12–13		300	275	60	85mw
RK6178	osc	15.75–16.25		300	200	60	25mw
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

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
RAYTHEON CO.—*(Continued)*							
QK294	osc	40–51.8		3k	200		5mw
QK295	osc	50–60		3.5k	200		
6BM6	osc	.55–3.0		325	355		50mw
6BM6A	osc	.55–3.0		325	355		50mw
QKK752	osc	7.125–7.65		300	350	25	140mw
QKK753	osc	7.75–8.4		300	350	25	140mw
QKK965	osc	5.925–6.425		750	390	25	1.4w
QKK910	osc	6.575–6.875		750	390	25	1.4w
QKK966	osc	6.875–7.125		750	390	25	1.4w
QKK967	osc	7.125–7.75		750	390	25	1.4w
QKK968	osc	7.75–8.4		750	390	25	1.4w
QKK826	osc	10.7–11.7		400	350	35	100mw
QKK869	osc	11.7–12.2		400	350	35	100mw
QKK822	osc	12.2–12.7		400	350	35	100mw
QKK877	osc	12.7–13.225		400	350	35	100mw
QKK873	osc	13.225–14		400	350	35	100mw
QKK874	osc	14–15		400	350	35	100mw
QKK878	osc	10.7–11.7		750	700	35	700mw
QKK899	osc	11.7–12.2		750	700	35	700mw
QKK978	osc	12.2–12.7		750	700	35	700mw
QKK880	osc	12.7–13.225		750	700	35	700mw
QKK881	osc	13.225–14		750	700	35	700mw
QKK882	osc	14–15		750	700	35	700mw
QKK607	osc	8.5–9.6		300,.025	200	50	40mw
QKK923	osc	23.5–24.5		375,.027	180	100	20mw
QKK834	osc	34–35.6		400,.027	150	120	20mw
QKK463A	osc	24.5–27.5		1800,.009	300	30	25mw
QKK892	osc	39.6–46		3000,.018	300		4mw
QKK893	osc	45.9–50		3000,.018	300		4mw
QKK863	osc	50–57		1400,.04	450	75	80mw
QKK864	osc	56–65		1400,.04	450	80	60mw
QKK865	osc	64–74		1400,.04	450	100	40mw
QKK837	osc	67–92					40mw
QKK369	osc	68.75–70.75					40mw
QKK838	osc	69–73					40mw
QKK866	osc	73–83		1400,.04	450	125	40mw
QKK867	osc	82–101		1700,.05	450	150	20mw
QKK977	osc	88–101					40mw
QKK971	osc	100-120		1700,.06	450	175	20mw
SPERRY ELECTRONIC TUBE DIV., Gainesville, Fla.							
SAL219	3 res,.0025	.96–1.215	4.2,37	24k,6.2			37kw
SAL81	e res,1	1.215–1.365	4.5,70	20k,5			21kw
SAL89	3 res,2.5	.96–1.215	4.2,40	20k,4.5			30kw
SAL153	6 res	1.27–1.40	12,45	190k,250			14megw
SAS28	3 res	2.6–2.7	9,13	4k,.35			225w
SAS60,A	3 res	2.67–3.33	6.3,2	1k,.3			25w
SAS60,B	3 res	2.7–2.93	6.3,2	1.4k,.65			20w
SAS61	3 res	2.7–2.9	6.3,6	15k,5.5			15kw
SAC9	3 res	4.97–5.09	6.3,.8	1k,.175			9w
SAC19	2 res	5.8,6.42	6.3,2	625,.16			6w
SAC33	3 res	4.8–5.3	7.6,5	5.4k,.45		±15mc	500w
SAC41	3 res	3.7–4.2	6.3,2	750,.2			30w
SAC225	3 res	4.2–6.8	4.75,56	130k,.98			3megw
SAC285	4 res,.1	C-band	6.3,4	33k,2.4		100mc	20kw
SAC259	3 res,.4	C-band	6.3,.75	6.6k,.214		±25mc	300w
SAC246	3 res	C-band	6.3,2.8	9k,.95			60w
SAC340	6 res	5.275–5.725	5,55	150k,116			5megw
SAX240	3 res, cw	X-band	6.3,2.8	6.25k,2.8			200w
SAX253	3 res, cw	10–10.5	6.3,2.8	8.75k,2.8			600w
SAU211	2 res, cw	12,6–18	6.3,1.6	1.7k,.14		±75mc	8w
SOU242	osc	12.5–15	6.3,.4	900,.04		±10mc	1.5w
SMS27	2 res	2.6–2.7	6.3,.4	1.25k,.025		±20mc	.5w
SMC11	2 res	4.5–5.7	6.3,1.1	1k,.05		50mc	1w
SMX32	3 res	9–10.5	6.3,1.6	1k,.15			3.5w
SMK40	3 res	23.5–26	6.3,2	1.5k,.17		±250mc	.6w
SOC150	3 res	4.91–5.01	6.3,.8	1.1k,.175			11w
SOU201	2 res	12.5–15	6.3,1.6	1.7k,.14			15w
SRL7	refl	1.7–2.4	6.3,2	1k,.22			10w
SRL17	refl	.75–.99	6.3,1.5	1k,.09			3w
SRC64D1	refl	5.43–5.93	6.3,.8	900,.09	750	500mc	1.8w
2K42	refl	3.3–4.2	6.3,1	1.25k,.06	750	300mc	1.5w
2K43	refl	4.2–5.7	6.3,1	1.25k,.06	750	450mc	1.25w
2K44	refl	5.7–7.5	6.3,1	1.25k,.06	750	500mc	1w
SRX92	refl	8.5–10.5	6.3,.45	300,.30	300	2kmc	30mw
2K25	refl	8.5–9.66	6.3,.44	300,.037		90mc	30mw
2K39	refl	7.5–10.3	6.3,1	1.25k,.06	750		1w
SRU55C	refl	15.7–17	6.3,.55	300,.031	350	45mc	25mw
SRU95	refl	12–4–15.5	6.3,.55	300,.032	253		52mw
SRU210	refl	15–7–17	6.3,.55	300,.035	110	50mc	20mw
SRV38	refl	34–35.6	6.3,.6	425,.04	400	60mc	30mw
SRV215	osc	34.2–35.4	6.3,.6	400,.04	500	110mc	30mw
SRU216	osc	15–17	6.3,.55	300,.031	500		20mw
SOC217	osc	4–6	6.3,.3	380,.015			300mw
SOC258	osc	C-band	6.3,.75	3.1k,.75		±25mc	1w
SAX151	ampl,5 res	9–9.5	5,25	80k,.45			1megw
SOX239	osc	8.2–12,4	6.3,.5	2.9k,.017			1w
SOX241	osc	8.2–12.4	6.3,.3	900,.033			1.5w
SOX254	osc	8.2–12.4	6.3,.8	515,.015			450mw
SRX230	refl	8.5–10.5	6.3,.45	300,.026			30mw
SRX232	refl	7–8.6	6.3,.45	400,.055	300		100mw
SRX233	refl	7–8.6	6.3,.45	400,.055	300		100mw
SRX262	refl	8.2–12.4	6.3,1.3	400,.045	400		100mw
SOU245	osc	12–13.5	6.3,1.7	1.75k,.14			5w
SRU226	refl	15–17	6.3,.55	300,.035	160		45mw
SRU266	refl	15–17	6.3,.55	300,.03	100		20mw
SRX265	osc	8.6	6.3,1.3	700,.058	430		1w

new pulse tubes for better definition in high power radar systems

Westinghouse offers two new High Vacuum Switch Tubes for pulse modulator service in radar systems: The WX 4450—highest power tube in the industry—is a 37 megawatt triode for very high voltage at high current. The WX 4675 delivers high voltage at medium current. These are two of a line of tubes developed to meet the latest military radar requirements. For more information, or application engineering assistance to solve your specific problems, write on your company letterhead to: Westinghouse Electric Corporation, P.O. 284, Elmira, N.Y. *You can be sure . . . if it's Westinghouse.*

Examples of Westinghouse high vacuum switch tube capabilities

	WX 4450	WX 4675
D.C. plate voltage	80KV	75KV
Peak plate current	600 Amps @ .01 duty	200 Amps @ .01 duty
	up to 1400 Amps special applications	up to 400 Amps special applications
Peak Power	37 megawatts typical, up to 90 megawatts on very short pulse width, low duty	14 megawatts typical, up to 26 megawatts on very short pulse width, low duty

Westinghouse

Circle 78 on Inquiry Card

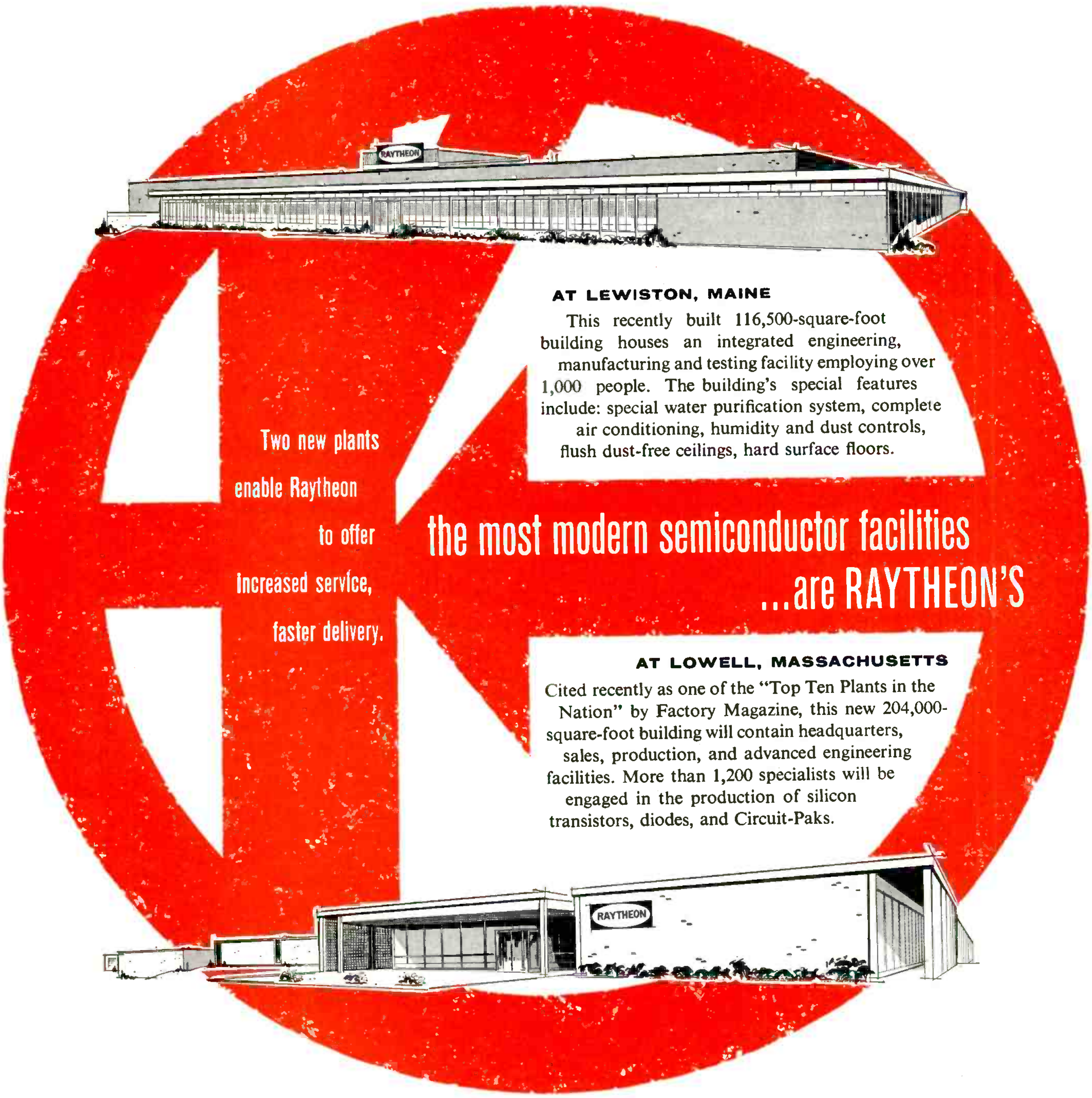
MICROWAVE ELECTRON DEVICES

KLYSTRONS—*(Continued)*

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Beam V;A	Refl V	Tun Range	Power Output
STANDARD TELEPHONES & CABLES, LTD., Brixham Rd., Paignton, Devon							
V190C/1M	osc,cw	.8–1	6.3,1	220,.08	220	4mc	2.5w
V218A/1K	osc,cw	1.7–2	6.3,.3	250,.05	270		.5w
V231C/1K	osc,cw	3.04–3.12	6.3,.25	200,.045	220	16mc	50mw
V233A/1K	osc,cw	2.7–4.2	6.3,.3	250,.065	270	2mc	.5w
V235A/1K	osc,cw	2.7–4.2	6.3,.3	250,.065	270	2mc	.7w
V237C1K	osc,cw	3.6–3.8	6.3,.26	255,.065	275	8mc	.4w
V238A/1K	osc,cw	3.5–4.3	6.3,.25	325,.05	355		1w
V239C/1K	osc,cw	3.8–4	6.3,.26	255,.065	275	8mc	.4w
V241C/1K	osc,cw	4–4.24	6.3,.26	260,.065	280	8mc	.4w
V243A/2F	osc,cw	4.2–4.4	6.3,.25	255,.065	275		.8w
V245C/1K	osc,cw	4.4–4.6	6.3,.3	240,.065	280	17mc	.3w
V246A/2K	osc,cw	4.65–4.86	6.3,.3	250,.065	270	6mc	.5w
V246C/4K	osc,cw	4.4–4.85	6.3,.3	320,.05	340	6mc	.5w
V247C/1K	osc,cw	4.6–4.8	6.3,.3	245,.065	285	17mc	.3w
V249C/1K	osc,cw	4.76–5	6.3,.3	265,.065	285	16mc	.3w
V261C/1M	osc,cw	5.85–6.35	6.3,.25	530,.06	550	17mc	1w
V265A/1M	osc,cw	5.85–7.1	6.3,.25	330,.06	350		.35w
V266C/1M	osc,cw	6.35–6.85	6.3,.25	530,.06	550	17mc	1w
V271C/3M	osc,cw	6.85–7.35	6.3,.25	530,.06	550	17mc	1w
V275C/3M	osc,cw	7.25–7.77	6.3,.25	530,.06	550	17mc	1w
Z211/1G	ampl,plsd	.96–1.21	12.6,1.8	5k,2.5	15k		8kw
Z220/1G	refl	1.7–2.3	6.3,.75	350,.05	250	16mc	250mw
Z237/1K	refl	3.5–3.54	6.3,.75	350,.055	200	43mc	150mw
Z239/1G	refl	3.6–4.2	6.3,1.1	1.1k,.07	700	45mc	1.2w
SYLVANIA ELECTRIC PRODS., Microwave Device Div., Mountain View, Calif.							
6BM6,A	refl	.55–3.8	6.3,.65	325,.018	235		175mw
5837	refl	1.6–3	6.3,.68	325,.028	235		175mw
6BL6	refl	1.6–6.5	6.3,.75	325,.028	220		250mw
5836	refl	1.6–6.5	6.3,.75	325,.028	220		250mw
6974	refl	4.6–5	6.3,.9	800,.11	410		1w
6468	refl	6.125–6.425	6.3,.9	750,.08	400		1w
6469	refl	6.575–6.875	6.3,.9	750,.08	400		1w
6470	refl	7.125–7.425	6.3,.9	750,.08	400		1w
K839B	refl	7.125–7.425	6.3,.9	750,.08	400		1w
K840B	refl	6.575–6.875	6.3,.9	750,.08	400		1w
K841B	refl	6.125–6.425	6.3,.9	750,.08	400		1w
K4008	refl	5.3–6.3	6.3,.9	750,.07	380		900mw
K4009	refl	5.3–6.6	6.3,.9	750,.07	390		900mw
K4010	refl	5.8–7.125	6.3,.9	750,.07	390		950mw
K4011	refl	6.3–7.5	6.3,.9	750,.07	360		800mw
220,222F	refl	5.925–6.225	6.3,.9	750,.08	400		1w
220,222E	refl	6.125–6.425	6.3,.9	750,.08	400		1w
220,222G	refl	6.425–6.575	6.3,.9	750,.08	400		1w
220,222D	refl	6.575–6.875	6.3,.9	750,.08	400		1w
220,222C	refl	6.875–7.125	6.3,.9	750,.08	400		1w
220,222B	refl	7.125–7.425	6.3,.9	750,.08	400		1w
220,222A	refl	7.425–7.75	6.3,.9	750,.08	400		1w
220,222Z	refl	7.75–8.1	6.3,.9	750,.08	400		1w
SK221H	refl	5.25–5.56	6.3,.4	250,.03	170		40mw
SK221K	refl	5.86–6.16	6.3,.5	300,.03	115		35mw
SK221F	refl	5,985–6.285	6.3,.5	300,.03	115		35mw
SK221E	refl	6.285–6.585	6.3,.5	300,.03	115		35mw
SK221G	refl	6.505–6.705	6.3,.5	300,.03	115		35mw
SK221D	refl	6.705–7.005	6.3,.5	300,.03	115		35mw
SK221C	refl	6.955–7.255	6.3,.5	300,.03	115		35mw
SK221B	refl	7.255–7.555	6.3,.5	300,.03	115		35mw
SK221A	refl	7.55–7.85	6.3,.5	300,.03	115		30mw
SKX105	refl	10–11	6.3,.75	400,.05	100		100mw
SKX101	refl	10.525	6.3,.75	300,.03	115		50mw
VARIAN ASSOCIATES, Tube Div., Palo Alto, California							
X12	refl	12.4–17.5		600		40mc	100mw
X13	refl	8.2–12.4		500		45mc	200mw
X13B	refl	7.5–11		500		45mc	200mw
V23	2 res osc	9.1–11		1350			5w
V24B	ampl,.0075	9–9.6		36k		100mc	40kw
V24C	ampl,.0075	9.0–9.6		36k		100mc	50kw
X26B,D,E,F	refl	5.3–7.5		750		35mc	1w
V27	2 res	9.1–11		1350			6w
V27B	2 res	8.5–10		1350			6w
VA28	2 res osc	13.35–13.65		2950			14w
VA39B,C	refl	10–15.5		650		25mc	50mw
V40B,C	refl	15–21		700		20mc	50mw
V45	mult	9–10		1k			1.15w
V53B,C	refl	10.7–11.7		300		40mc	50mw
V54	refl	10.5–12.2		400		45mc	200mw
V55,B	refl	8.2–11.5		500		45mc	300mw
V58,C	refl	8.5–10		500		45mc	600mw
V63	2 res osc	8.0–9.5		1260			5w
V67B	2 res osc	13.35–13.65		1550			1w
V82	ampl,.025	9.31±0.13		17k		fix	7kw
V87B,C	ampl,.002	2.7–2.9		105k		±50mc	2mw
VA92	refl	14–17.5		600		40mc	100mw
VA64F,G	2 res osc	13.5,13.3		3k			18w
VA92B	refl	12.4–14.5		600		55mc	200mw
VARIAN ASSOCIATES—*(Continued)*							
VA92C	refl	12.4–14.5		600		55mc	200mw
VA93	refl	13.3–12.7		250			20mw
VA94	refl	16–17		300		65mc	40mw
VA94B	refl	15.8–16.2		300		65mc	30mw
VA96	refl	22–25		750		120mc	30mw
VA96B	refl	22–25		750		100mc	80mw
VA97	refl	34–35.6		400		100mc	15mw
VA97B	refl	32.6–34		400		90mc	20mw
VA98	refl	23.6–24.4		375		75mc	20mw
VA113,114,115	refl	5.92–7.72		750		20mc	300mw
V151	refl	8.5–10		300		25mc	25mw
V153	refl	8.5–10		250		60mc	70mw
V154	refl	10.5–12.2		400		45mc	200mw
VA157	refl	8.5–10		385		60mc	70mw
VA201B	refl	8.5–9.6		300		40mc	60mw
VA203B	refl	8.5–9.6		300		50mc	30mw
VA210B	refl	9.6–10.8		300		40mc	30mw
VA217C	refl	8.5–9.6		250		50mc	30mw
VA220AG,Z	refl	5.92–8.1		750		40mc	1w
VA221BG	refl	5.92–7.45		300		40mc	40mw
VA221H	refl	5.25–5.56		250		35mc	40mw
VA222AG,Z	refl	5.92–8.1		750		40mc	1w
VA225A,B,C	refl	7.0–8.5		750		30mc	1w
VA232	refl	9.2–10		350		40mc	225mw
VA242 Ser.	refl	8.5–11		500		55mc	870mw
VA244A,B,C	refl	5.8–7.9		750		50mc	1w
VA246	refl	12–14		500			500mw
VA249 Ser.	refl	8.5–11		300		30mc	100mw
V260	refl	8.5–10		300		48mc	70mw
V262	refl	8.5–10		300		48mc	50mw
V270	refl	8.5–10		300		40mc	70mw
V290	refl	8.5–10.5		350		65mc	120mw
VA800	cw ampl	1.7–2.4		15k		700mc	10kw
VA800C	cw ampl	2.16–2.4		15k		240mc	10kw
VA802B	cw ampl	1.7–2.4		6k		700mc	1kw
VA804	cw ampl	4.4–5.875		9k		±75mc	2kw
VA804L	cw ampl	4.4–5.0		9k		600mc	2kw
VA805	cw ampl	5.875–6.425		9k		±25mc	2kw
VA806	cw ampl	7.125–8.5		8k		±25mc	1kw
VA808	ampl,.016	5.3–5.9		22k		±25mc	20kw
VA812C	ampl,.0037	.40–.45		160k		50mc	8mw
VA816J	ampl,.004	3.43–3.57		115k		fix	2.5mw
VA820B,C	ampl,.002	2.7–2.9		130k		fix	5mw
VA822	cw ampl	9.0–11		8k		200mc	1kw
VA823	cw ampl	7.5–10		15k		100mc	5kw
VA833C	cw ampl	.680–.985		11.5k		305mc	11kw
VA834B	cw ampl	4.4–5		7.5k		600mc	1kw
VA838	cw ampl	.470–.685		15k		315mc	20kw
VA839	ampl,.002	2.73–2.87		125k		fix	5mw
VA842	ampl,.06	.40–.45		107k		50mc	1.25mw
VA845	ampl,.10	9.3–9.6		14k		50mc	5kw
VA846	cw ampl	4.4–6		12.5k		150mc	5kw
VA848	cw ampl	9.0–10.8		10k		200mc	2kw
VA849	cw ampl	7.125–8.5		23k		60mc	20kw
VA851	cw ampl	10–10.55		10.5k		250mc	2.5kw
VA856	cw ampl	7.125–8.5		9.5k		300mc	2kw
VA220J	refl	4.9–5.2		750		21	.6w
VA508	2 cav osc	8–9.5		825			.8w
VA824B	2 cav ampl	9.8		750			2w
VA401	3 cav ampl	9.8		1k			10w
VA204	refl	10.525		300			25mw
VA218B	refl	10.525		300			25mw
VA503C	2 cav osc	13.3		1.5k			1w
VA504B	2 cav osc	13.3		3k			15w
VA67B	2 cav osc	13.35–13.65		1.6k			.75w
VA503B	2 cav osc	13.5		1.5k			1w
VA403	4 cav ampl	13.325		1.2k			5w
VA240	refl	17–19		750		40	.2w
VA239	refl	34–35.6		2.5k		50	.25w
VA99	refl	68–72		2.5k		100	.25w
VA250	refl	68–74		2.5k		100	10mw
VA87B,C		2.7–2.8		100k			2kw
VA850		2.7–2.9		250k			25kw
VA853		.755–.985		26k			75kw
VA863		7.125–8.5		17k			10kw
WESTINGHOUSE, Electronic Tube Div., P.O. Box 284, Elmira, N.Y.							
WL6781	osc, cw	8.5–9.6	6.3,1.2	200,.016	105		20mw
WX4618	refl osc	9.2	6.3,1	350	200		120mw
WL6310	refl osc	8.5–10	6.3,1	300	150		70mw
WL6312	refl osc	8.5–10	6.3,1	300	150		70mw
WL6316	refl osc	8.5–10	6.3,1	200	105		20mw
WL6780	refl osc	8.5–10	6.3,1	200	105		25mw
WL6915	refl osc	8.5–10	6.3,1	300	150		70mw
WL6315	refl osc	8.5–10	6.3,1	250	90		70mw
WL6314	refl osc	8.5–10	6.3,1	350	150		120mw

BACKWARD WAVE TUBES

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Power Output
BENDIX, Red Bank Div., Eatontown, N. J.						
TWO66	osc	61–71	6.3	2.5k	2k	3mw
TWO67	osc	49–59	6.3	3k	sol	7mw
TWO82	osc	50–60		2.5k	sol	7mw
BENDIX—*(Continued)*						
TWO75	osc	40–50		2.5k	sol	10mw
TWO85	osc	70–85		3.1k	sol	4mw
TWO87	osc	85–100		3.1k	sol	2.5mw



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Circle 79 on Inquiry Card

MICROWAVE ELECTRON DEVICES

BACKWARD WAVE TUBES—*(Continued)*

Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Power Output
BENDIX—*(Continued)*						
TW083	osc	65–75	6.3	2.9k	sol	6mw
TW088	osc	32–40	6.3	2.5k	sol	20mw
TW089	osc	50–60	6.3	2.5k	pm	5mw
TW090	osc	100–120	6.3	3.2k	sol	1.5mw
TW091	osc	40–50	6.3	2.5k	sol	5mw
TW093	osc	120–140	6.3	3.2k	sol	1mw
COMPAGNIE GENERALE DE T.S.F., 79 Boulevard Haussman, Paris 8, France						
CD515A	osc	.98–2.1		1.5k		1w
CO210A	osc	1.6–3.2		1.6k		.7w
CO127A	osc	2–4		1.6k		.7w
CO119A	osc	2.4–4.7		1.5k		.6w
CO94A	osc	3.6–7.2		1.5k		.35w
CO63A	osc	4.8–9.6		1.5k		.25w
CO43A	osc	7–11		1.5k		.35w
CO521A	osc	8–16		1.9k		.15w
CO2012B	osc	15.5–24		2.45k		.4w
CO1308B	osc	23.5–37.5		3.2k		.35w
CO40	osc	68–72		6k		3w
CO20	osc	130–150		6k		.1w
ENGLISH ELECTRIC VALVE CO., LTD., Chelmsford, England						
N1010	osc	7–11.5	6.3,2.3	1.4k	pm	170mw
N1034	osc	2.4–4.5	6.3–2.4	1.13k	pm	800mw
N1010A	osc	7–11.5	6.3,2.3	1.4k	pm	170mw
N1010S	osc	7–11.5	6.3,2.3	1.4k	sol	170mw
N1034A	osc	2.4–4.5	6.3,2.4	1.13k	pm	800mw
N1034S	osc	2.4–4.5	6.3,2.4	1.13k	sol	800mw
HUGGINS LABORATORIES, INC., 999 E. Arques Ave., Sunnyvale, Calif.						
BA1	ampl	2.4–3.6	6.3,2.3	1.5k	820	
BA2	ampl	8.2–12.4	6.3,1.2	2.4k	1k	
BA4	ampl	12–18	6.3,1.2	2k	1k	
HO1	osc	2–4		3.4k	760	10mw
HO2	osc	8.2–12.4	6.3,1.2	2k	1k	10mw
HO3	osc	3.75–7	6.3,1.2	2.6k	675	1mw
HO4	osc	12.4–18	6.3,1.2	2.2k	1k	10mw
HO9	osc	1–2	6.3–2.5	2.8k	800	10mw
HO10	osc	3.7–5.9	6.3,2	2k	1k	10mw
HO11	osc	5.2–8.3	6.3,1.4	2k	1k	10mw
HO13	osc	4–8	6.3,1.4	2.4k	1k	1mw
HO14	osc	8.2–12.4	6.3,1.2	2k	1k	1mw
HO17	osc	7–11	6.3,1.2	2k	1k	1mw
HO18	osc	2–4	6.3,2	3.4k	760	1mw
HO19	osc	12–18	6.3,1.2	2.2k	1k	1mw
HO20	osc	3.75–7	6.3,1.4	2.6k	1k	10mw
HO21	osc	4–8	6.3–1.4	2.4k	1k	10mw
HUGHES, Microwave Tube Div., 11105 La Cienega Blvd., Los Angeles 45, Calif.						
357H	osc	8.4–9.375			pm	200mw
333H	osc	7.4–12			pm	30mw
346H	osc	7–12.4			pm	30mw
348H	osc	7–12.4			pm	20mw
356H	osc	10–15			pm	10mw
358H	osc	10–15			pm	10mw
329H	osc	10–16.5			pm	5mw
339H	osc	12.5–17.5			pm	20mw
316H	osc	12.4–18			pm	10mw
326H	osc	12.4–18			pm	10mw
328H	osc	12.4–18			pm	10mw
315H	osc	15.8–17.2			pm	50mw
366H	osc	15–20			pm	10mw
368H	osc	15–20			pm	10mw
ITT, Components Div., P.O. Box 412, Clifton, N.J.						
Y257/1E	osc	4–8.5	6.3,.9	1.5k	sol	120mw
Y330/1E	osc	26–40	6.3,.9	3k	sol	50mw
LITTON INDUSTRIES, Electron Tube Div., San Carlos, Calif.						
L3148	osc	8.5–11	6.6	5.2k		150w

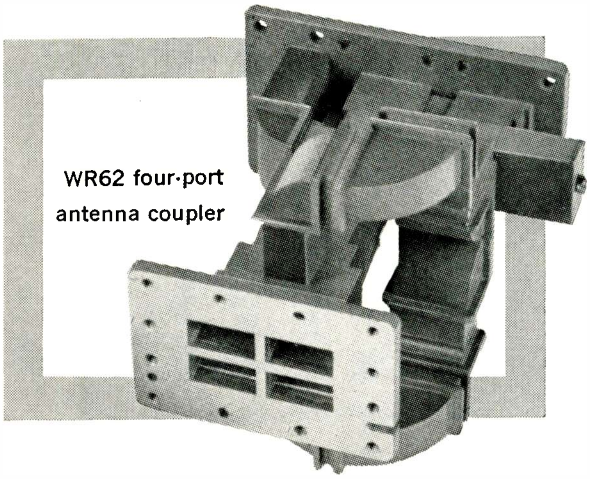
Type	Description App; Du. Cy.	Frequency (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Power Output
RAYTHEON CO., Microwave & Power Tube Div., Waltham, Mass.						
QK518	osc	2–4	6.3–1.5	1.5k		1w
QK528	osc	3.6–7.2	6.3,1	1.45k		400mw
QK625	osc	2.5–3	10,2	4.95k		300w
QK610	tun	6.7–11.4	6.3–1.5	1.5k		300mw
QKB786	osc	1–2	6.3	1.5k		100mw
QKB816A	osc	2–4	6.3	1.5k		70mw
QKB760A	osc	4–8	6.3	1.5k		30mw
QKB776	osc	8–12	6.3	1.5k		50mw
QKA659	osc	3.25–4.49				250w
QKA773	osc	8.5–11				200w
QKB913	osc	1.0–2.0		1.1k		100mw
QKB794	osc	1.97–4.03				20mw
QKB914	osc	2.0–4.0		1.4k		70mw
QKB691	osc	2.0–4.0		1.45k		1w
QKB708	osc	2.04–4.08				20mw
QKB924	osc	2.7–3.2		640		400mw
QKB795	osc	3.6–7.3				30mw
QKB709	osc	3.92–7.5				20mw
QKB915	osc	4.0–8.0		1.345k		20mw
QKB909	osc	5.3–5.9		720		50mw
QKB728	osc	5.37–5.93				100mw
QKB734	osc	5.37–5.93				100mw
QKB796	osc	6.7–11.4				20mw
QKB931	osc	7.2–12.4		1.25k		200mw
QKB710	osc	7.4–12				20mw
QKB916	osc	8.0–12.4		1.25k		20mw
QKB830	osc	8.5–9.6		250		10mw
QKB938	osc	8.5–9.6		520		50mw
QKB890	osc	12.4–18.0		1.25k		15mw
QKB891	osc	18.0–26.5		2.5k		15mw
STANDARD TELEPHONES & CABLES, LTD., Brixham, Paignton, Devon						
Y257/1E	osc	4–7.5	6.3,.9	1.5k	sol	120mw
Y257/2E	osc	4–7.5	6.3,.9		pm	120mw
Y322/1E	osc	18–27	6.3,.3	3k	sol	80mw
Y330/1E	osc	26.5–40	6.3,.3	3.2k	sol	80mw
STEWART ENGINEERING CORP., Santa Cruz, Calif.						
OD1–2	osc	1–2	6.3,.78	1.5k	800	50mw
OD1–2.6	osc	1–2.6				
OD1.5–2.5	osc	1.5–2.5				
OD2–4	osc	2–4	6.3,.78	2.5k	800	30mw
OD2.3–4.45	osc	2.3–4.45				
OD3–5	osc	3–5				
OD3.7–5.9	osc	3.7–5.9	6.3,.78	2.5k	800	30mw
OD4–8	osc	4.8	6.3,.78	2.5k	800	10mw
OD5.2–8.3	osc	5.2–8.3	6.3,.78	2.5k	800	10mw
OD5.4–5.9	osc	5.4–5.9	6.3,.9	.7k	800	50mw
OD6–11	osc	6–11	6.3,.64	2.5k	800	10mw
OD6–12	osc	6–12	6.3,.64	2.5k	800	10mw
OD7–13	osc	7–13	6.3,.64	2.5k	800	10mw
OD10–15	osc	10–15	6.3,.73	2.5k	800	10mw
OD12–18	osc	12–18	6.3,.73	2.5k	800	10mw
OD15–22	osc	15–22				
OD18–27	osc	18–27				
SE201	osc	7–12.4	6.3,.9	2k	ppm	10mw
SE202	osc	8.2–12.4	6.3,.9	1.5k	ppm	10mw
VARIAN ASSOCIATES, Tube Division, Palo Alto, Calif.						
VA161	osc	8.2–12.4		650		80mw
VA161B	osc	7.5–11		550		40mw
VA162	osc	12.4–18		850		40mw
VA163	osc	18–27		1.1k		10mw
VA164	osc	27–40		1.1k		10mw
VA168	osc	8–10		800		80mw
VA169	osc	7.5–11		875		200mw
VA179	osc	3.1–5.5		1k		50mw
VA181	osc	2–4		2k	es.	10mw
WATKINS-JOHNSON CO., 3333 Hillview Ave., Palo Alto, Calif.						
WJ205	osc,cw	15–18		12kv	pm	100w
WJ216	osc,cw	.3–.6	6.5,.8	2.9kv	es	30mw
WJ208	osc,cw	.5–1		1.9kv	es	1mw

TRAVELING WAVE TUBES

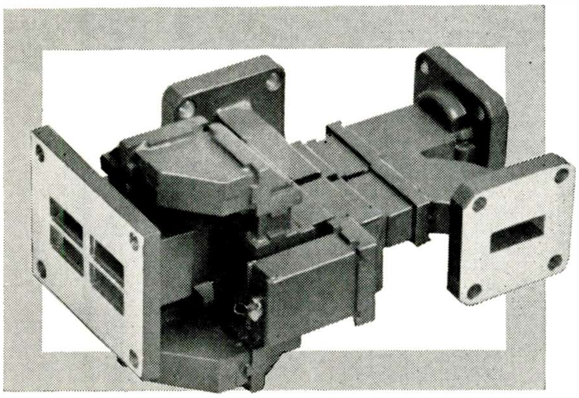
Type	Description App; Du. Cy.	Freq. (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
AMPEREX ELECTRONIC CORP., 230 Duffy Ave., Hicksville, L.I., N.Y.								
55340	ampl	3.8–4.2	6.3,.8	1.1k	600	37		8w
7537	ampl	4.4–5	6.3,.8	1.1k	600	34	6w	6w
BRITISH INDUSTRIES CORP., 80 Shore Road, Port Washington, N.Y.								
TWS1	ampl	1.5–3		2.2k	600*	48		35w
TWC4	ampl	6–7.5		2.6k	600*	40		2w
TWC5	ampl	5.9–8		1.8k		38	30	10w
TWS6	ampl	2.5–4.1		2.4k	500*	20	30	0.5w
TWS7	ampl	2.7–3.5		2.4k	500*	20	30	3w
TWX8	ampl	7–11.5		2.8k	pkgd	25	30	0.75w
*Oersted								
CANADIAN MARCONI CO., 2442 Trenton Ave., Montreal 16, Canada								
N1001	ampl	1.7–2.3	6.3,1.6	2.8k	400	25		16w
B202	ampl,cw	1.7–2.3	6.3,1.6	2.5k	600	40	35	10w

Type	Description App; Du. Cy.	Freq. (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
COMPAGNIE GENERALE DE T.S.F., 79 Boulevard Haussman, Paris 8, France								
TPO101	ampl	2.7–3.3		400	pm	30	5.8	1.5mw
TPO741	ampl	3.8–4.2		400	pm	25	6.5	2mw
TPO301	ampl	8.5–9.6		800	pm	25	8	1mw
TPO153A	ampl	1.7–2.7		2.6k	pm	32		7w
TPO921	ampl	3.6–9.2		1.1k	pm	20		2w
TPO430	ampl	3.8–4.2		2k	pm	25		6w
TPO570	ampl	3.8–4.2		2k	pm	28.5		15w
TPO410	ampl	5.9–7.4		1.9k	pm	25		6w
TPO925	ampl	1.215–1.35		1k	pm	30		6.6wp
TPO125	ampl	1.215–1.35		12k	pm	27		4kwp
TPO103	ampl	2.9–3.1		1.7k	pm	27		10wp
TPO902	ampl	2.5–4.2		260	pm	30	12	
EITEL-McCULLOUGH, INC., San Carlos, Calif.								
X778	ampl	5–11	6.3,0.6	3k	ppm	60	34	1w

MDL MONOPULSE ANTENNA COUPLERS



WR62 four-port antenna coupler



WR42 four-port antenna coupler

MDL monopulse antenna couplers are designed from proven stock components, resulting in quick delivery and lower costs. Exacting quality control assures interchangeability of assemblies and simplified systems design. Each coupler is shipped with certified test results.

MDL monopulse couplers have met these general specifications:

Bandwidth: **10%**	
At antenna ports —	
phase relationship:	0° & 180°
phase error:	2° max.
phase deviation with frequency:	2° max.
output unbalance:	0.25 db max.
Sum channel VSWR:	1.15 max.
Difference channel VSWR:	1.25 max.

What are *your* monopulse antenna feed requirements? Send us your specifications today for a prompt quotation.

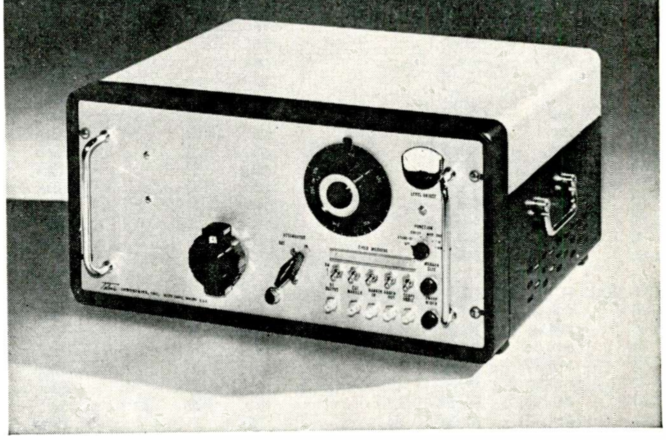
MDL ***Microwave Development Laboratories, Inc.***

15 Strathmore Road • Natick Industrial Centre • Natick, Massachusetts

telephone: OLympic 5-1400 • CEdar 5-6252 • TWX: NTK 295

Circle 80 on Inquiry Card

High Power Sweep To 1250 MC From TELONIC



With a maximum output of 14 volts — 4 watts, Telonic PD Sweep Generators provide a new era in sweep techniques. They operate in 4 different modes — swept RF, modulated swept RF, CW, and modulated CW—selected by a function switch. Their display linearity is better than 1.2:1, and output is flat within ±7.5% over the maximum sweep width.

The instrument's built-in turret attenuators provide a range of 0 to 59 db in 1 db steps with direct dial readout of attenuation value. Provisions for an external marker and fixed plug-in markers are also included.

Available in 7 models covering various frequency ranges up to 1250 mc, the PD units are ideal for high power applications. Since their output level is 100 times greater than that of other sweep generators, the usefulness of swept techniques is greatly expanded. In fact, the response of a device having as much as 60 or 70 db loss can be easily displayed on a high-gain oscilloscope with a PD unit.

Specifications on all PD models may be obtained from Technical Bulletin T-217B.

Telonic INDUSTRIES, INC.

BEECH GROVE, INDIANA—PHONE STATE 7-7241

NEED ONE NOW? 24 HOUR DELIVERY VIA TELONIC JET ORDER SERVICE

Circle 81 on Inquiry Card

TRAVELING WAVE TUBES—*(Continued)*

Type	Description App; Du. Cy.	Freq. (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
ENGLISH ELECTRIC VALVE CO., LTD., Chelmsford, England								
6861	ampl	1.7–3.5	5,.5	375	525	25	6.5	1mw
N1001	ampl	1.7–2.3	6.3,1.5	2.63k	450	25		15w
N1002	ampl	1.7–2.3	6.3,.36	565	450	23	9	2.5mw
N1004	ampl	3.8–4.2	6.3,.68	2.2k	500	24		5w
N100M	ampl	3.6–4.2	6.3,.36	380	350	20	9	1mw
N1013	ampl	1.7–2.3	6.3,.36	650	400	33	20	250mw
N1016M	ampl	4.1–7	6.3,.36	585	520	40	9	4.5mw
N1017M	ampl	1.2–1.4	6.3,.36	260	450	26	6.5	2mw
N1018M	ampl	3.6–4.2	6.3,.36	600	400	33	21	100mw
N1024M	ampl	3.6–4.2	6.3,.36	380	350	20	9	1mw
N1025M	ampl	3.6–4.2	6.3,.36	600	400	33	21	100mw
N1029	ampl	5.9–7.2	6.3,1.2	2.65k	600	43		9w
N1031	ampl	3.8–4.2	6.3,.36	490	550	25	8.5	2.3mw
N1032	ampl	3.8–4.2	6.3,.36	1.45k	350	38	19	300mw
N1033	ampl	3.8–4.8	6.3,.71	2.175k	550	37		7w
GEISLER LABS., P. O. Box 353, Woodland Hills, Calif.								
G020P	ampl	.5–1			pm			10mw
G050P	ampl	1–2			pm			10mw
G100P	ampl	2–4			pm	30		10mw
G200P	ampl	4–8			pm	30		10mw
G400P	ampl	8.2–12.4			pm			20mw
G110P	ampl	2–4			pm			30mw
G210P	ampl	4–8			pm			10mw
G020	ampl	.5–1			sol			10mw
G050	ampl	1–2			sol			10mw
G100	ampl	2–4			sol	30		30mw
G200	ampl	4–8			sol	30		30mw
G400	ampl	8.2–12.4			sol	34		20mw
G070	ampl	1–2			sol	32		10mw
G110	ampl	2–4			sol	34		30mw
G210	ampl	4–8			sol	32		30mw
G410	ampl	8.2–12.4			sol			30mw
G120	ampl	2–4			sol	30		10mw
G420	ampl	8.2–12.4			sol			
GENERAL ELECTRIC CO., Power Tube Dept., Schenectady 5, N.Y.								
GL7393	ampl,cw	4–8	6.3,.3	500	pm	25	10	5mw
Z3031	ampl,cw	14–18	6.3..3	1.2k	pm	25	14	5mw
Z3040	ampl,cw	35–40			em	20	15	3mw
Z3086	ampl,.005	8.5–9.6			ppm	60		50kw
Z3088	ampl,cw	7–11	6.3,.3	780	ppm	35	15	5mw
Z3090	ampl,.005	8.5–9.6	4.3.8		1500	30		5kw
Z3091	ampl,.004	8.5–9.6	6,8		1700	20		250kw
ZM3092	ampl,.02	5.4–5.9			ppm	30		25kw
ZM3093	ampl,cw	7.5–8.5	6.3,.3	850	pm	25	7	3mw
ZM3103	ampl,cw	7–11	6.3,.3	850	pm	25	10	5mw
ZM3105	ampl,cw	7–11			ppm	35	15	15mw
ZM3107	ampl,cw	6–12			ppm	35		10w
ZM3110	ampl,cw	4–8			ppm	25	10	5mw
ZM3113	ampl,cw	2–4			pm	20	5	1mw
ZM3115	ampl,cw	18–26.5			ppm	25	13	1mw
ZM3116	ampl,cw	26–40			ppm	20	15	1mw
GL7394	ampl	8–12	6.3,.3	850	pm	25	10	5mw
Z5182	ampl,cw	14–18	6.3,.31	1.8k	ppm	30	25	150mw
Z5183	ampl,cw	14–18	6,.5	3.5k	ppm	30	30	10w
Z5184	ampl,.01	14–18			sol	25		1kw
HUGGINS LABORATORIES, INC., 999 E. Arques Ave., Sunnyvale, Calif.								
HA1	ampl	2–4	6.3,1	525	300	30		10mw
HA2	ampl	2–4	7,1.2	1.1k	600	30		1w
HA4	ampl	8–12.4	6.3,1.2	1.3k	400	30		10mw
HA5	ampl	1–2	6.3,1.4	220	400	30		10mw
HA6	ampl	4–8	7,1.3	1.5k	1k	30		0.5w
HA7	ampl	0.5–1	6.3,1.5	120	300	30		10mw
HA8	ampl	0.5–1	7,2.2	500	560	30		1w
HA9	ampl	8–11	6.3,1.2	2.4k	1k	33		0.5w
HA10	ampl	8.2–12.4	7,1.2	2.3k	1k	25		100mw
HA18	ampl	1–2	7,1.4	750	1k	33		2w
HA20	ampl	8–11	6.3,1.2	1.3k	ppm	30		10mw
HA21	ampl	8–11	7,1.2	2.4k	ppm	33		0.5w
HA22	ampl	1.6–2.6	6.3,1	500	300	30		10mw
HA24	ampl	12.4–15	6.3,1.2	1.3k	400	20		5mw
HA25	ampl	12–18	6.3,1.4	1.3k	1k	30		5mw
HA26	ampl	4–8	6.3,1	800	400	30		10mw
HA28	ampl	4–8	6.3,1	800	ppm	30		10mw
HA29	ampl	2–4	6.3,1	525	ppm	30		10mw
HA30	ampl	2–4	7,1.2	1.1k	ppm	30		1w
HA31	ampl	1–2	6.3,1.4	220	ppm	30		10mw
HA35	ampl	4–8	7,1.3	1.6k	ppm	30		0.5w
HA36	ampl	0.5–1	6.3,1.4	300	ppm	20		10mw
HA39	ampl	1.6–2.6	7,1.2	1.25k	600	30		1w
HA49	ampl	10.5–16	6.3,1.2	1.3k	ppm	30		3mw
HA51	ampl	0.25–0.5	6.3,1.5	220	ppm	20		10mw
HA53	ampl	1–2	7,1.4	1k	ppm	30		2w
HA71	ampl	8–12.4	7,1.2	2.3k	ppm	25		100mw
HA11	ampl	2–4	5,1.1	475	500	25	15	1mw
HA14	ampl	1–2	5,0.8	200	1k	25	10	1mw
HA17	ampl	1–2	5,0.8	200	1k	25	15	1mw
HA19	ampl	1.6–2.6	5,0.8	200	1k	25	15	1mw
HA23	ampl	8.2–11	5,1.1	1.25k	1k	25	10	1mw
HA32	ampl	4–8	5,1.1	700	1k	25	15	1mw
HA37		4.4	6.3,1	475		25	10	1mw
HA40	ampl	0.5–1	5,1	120	820	25	15	1mw
HA43	ampl	12–18	5,1.4	1.3k	1k	25	17	1mw
HA44	ampl	8.2–12.4	5,1.1	1.25k	1k	25	15	1mw
HA45	ampl	0.5–1	5,1	120	820	25	10	1mw
HUGGINS LABORATORIES, INC.—*(Continued)*								
HA46	ampl	12–18	5,1.4	1.3k	1k	25	12	1mw
HA47	ampl	4–8	5,1.1	700	1k	25	10	1mw
HA48	ampl	12–16	5,1.4	1.3k	1k	25	13	1mw
HA54	ampl	2–4	5,1	800	ppm	25	15	3mw
HA60	ampl	8–11	6.3,1.2	1.25k	ppm	25	17	10mw
HA61	ampl	7–14	5,1.1	1.3k	1000	25	15	1mw
HA62	ampl	2–4	5,1	500	BS–53C	25	10	5mw
HA73	ampl	1–2	5,0.8	200	1000	25	8	1mw
HA86	ampl	0.5–1	5,1	120	800	25	7	1mw
HA89	ampl	2–4	5,1.1	450	BS–67C	20	8	10mw
PA1		8–11	7,1.4			30		
PA3			7,1.2					
PA4	ampl,0.1	2–4	7,1.2	950	600	33		1w
PA5		8–12.4	7,1.2					300mw
PA6			7,1.2	1k	ppm	30		1w
PA7					1k	30		
PA8	ampl,0.1	4–8	7,1.2	1.6k	ppm	30		1w
PA9			7,1.4					
PA10	ampl,0.1	2–4	7,1.2	1.1k	ppm	30		10w
DA1	v. tun	2–4	6.3,0.85	2.38k	250	28		
DA2	v. tun	1–2	6.3,1.2	1.02k	250	33		
DA3	v. tun	0.5–1	6.3,1.1	1065	250	30		
DA4	v. tun	4–8	6.3,1.1	2.5k	400	25		
HA16	mult	1.76/8.8	7,1.2	1.2k	600	–10		2mw
HA34	mult	0.4–1/2–4	6.3,1	250	550	–10		2mw
HUGHES, Microwave Tube Div., 11105 La Cienega Blvd., Los Angeles 45, Calif.								
314H	ampl,cw	1.9–2.1			ppm	33		2.5w
349H	ampl,cw	2.2–2.4			ppm	23		10w
351H	ampl,.01	2.3–2.9			ppm	33		1kw
362H	ampl,.005	2.7–2.9			ppm	46		100w
363H	ampl,cw	2–4			ppm	35		1w
343H	ampl,cw	2.7–3.3			ppm	45		4.5w
334H	ampl,.006	2.9–3.1			ppm	30		1kw
354H	ampl,.02	2.9–3.1			ppm	32		1.3kw
364H	ampl,.005	2.8–3.2			ppm	31.5		1kw
321H	ampl,.006	2.85–3.15			ppm	26		250kw
312H	ampl,.005	2–4			ppm	30		1kw
374H	ampl,.006	2–4			ppm	30		1kw
304H	ampl,.01	2–4			ppm	30		1kw
340H	ampl,.01	2–4			ppm	30		1kw
311H	ampl,.01	2–4			ppm	30		1kw
350H	ampl,.01	2–4			ppm	30		1kw
361H	ampl,.02	2.9–3.6			ppm	30		1kw
341H	ampl,.01	2.5–4			ppm	33		1kw
344H	ampl,.005	3.35–3.65			ppm	32		1.5kw
306H	ampl,.02	5.4–5.9			ppm	43		20kw
319H	ampl,.01	8.4–9.5			ppm	54		20kw
378H	ampl,.01	8–10			ppm	45		20kw
337H	ampl,.01	8.6–9.8			ppm	53		15kw
307H	ampl,.01	8.55–9.45			ppm	50		50kw
347H	ampl,.01	8.55–9.45			ppm.	50		50kw
308H	ampl,.01	8.45–9.95			ppm	52		15kw
310H	ampl,.02	8.2–11.4			ppm	40		1kw
392H	ampl,cw	2–4			ppm	30		1w
ITT, Components Div., P.O. Box 412, Clifton, N.J.								
F6658	ampl,cw	1.7–4	6.3,2.5	1.25k	750	30		5w
F6825	ampl,.005	2–4	6.3,5	8.5k	1.2k	30		2kw
F6826	ampl,.005	2–4	6.3,5	8.5k	1.2k	30		1.5kw
F6867	ampl,cw	8–9.6	6.3,.85	1.5k	1.3k	30		100mw
F6868	ampl,cw	1.7–4	6.3,2.5	1.5k	1k	30		10w
F6996	ampl,cw	8–9.6	6.3,2.3	3.4k	1.3k	30		10w
F7066	ampl,cw	8–12	6.3,.85	1.6k	900	30		50mw
F7067	ampl,.04	8–12	6.3,2.3	4.5k	1.2k	30		1w
F7338	ampl,.005	2–4	6.3,5	8.5k	1.2k	40		1kw
F7339	ampl,.005	8.5–9.6	6.3,2.5	12k	2.8k	27		1kw
F7340	ampl,.005	8–9.6	6.3,5.2	12k	2.4k	30		1kw
F7341	ampl,cw	8–9.6						5w
F7347	ampl,.005	2–4	6.3,5.2	8k	1.2k	30		1kw
F7524	ampl,cw	8–12	6.3,1.7	4k	1.2k	20		5w
F7525	ampl,cw	8–12	6.3,1.7	4k	sol	20		5w
F7526	ampl,cw	8–12	6.3,.85	1.6k	sol	30		50mw
F7847	ampl,cw	5–6	6.3,2.2	3k	1.2k	27		10w
F7848	ampl,.005	5.4–5.9	6.3,5.2	17k	2k	27		2kw
D2004	ampl,.04	8–9.6	6.3,2.3	3.4k	1k	25		5w
D2009	ampl,.04	3.95–8	6.3,2.5	2.5k	sol	35		2w
D2013	ampl,cw	8–9.6	6.3,2.3	3.4k	1.3k	33		5w
D2014	ampl,.005	8–9.6	6.3,5.2	12k	2.4k	33		1kw
D2023	ampl,.01	4–8	6.3,5	10k	2k	30		1kw
X282	ampl,cw	4–8	6.3,1.5	3k	1.2	25		10w
X354	ampl,cw	8–12	6.3,2		pm	33		5w
X368	ampl,cw	8–12	6.3,.85		pm	35		50mw
X370	ampl,cw	4–8	6.3,2		pm	33		10w
W5/1G	ampl,cw	5.8–7.15	6.3,.85	3.2k		40		18w
W7/4G	ampl,cw	3.6–4.2	6.3,.85	3.15k		42		10w
W9/1E	ampl,cw	2.5–4.1	6.3,.75	450		28	21.5	120mw
W10/3E	ampl,cw	2.7–3.3	5,.6	550		25	6.2	1w
LITTON INDUSTRIES, Electron Tube Div., San Ca los, Calif.								
L3236	ampl,cw	7–11			ppm	36		2w
L3266	ampl,cw	7–11			ppm	36		20mw
L3470	ampl,cw	4–8			ppm	36		20mw
L3471	ampl,cw	4–8			ppm	36		2w
L3472	ampl,cw	7–11			ppm	36		10w
L3499	ampl,cw	2–4			ppm	36		2w
L3528	ampl,cw	5–11			ppm	33		5w
L3529	ampl,ew	7–11			ppm	36		20w

(Continued on page 162)

New Products

VARIABLE ATTENUATOR

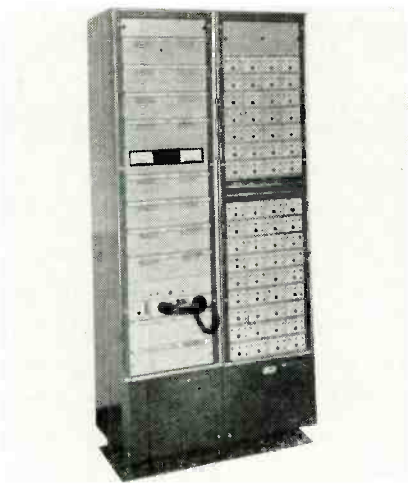
Coaxial unit for lab or for use in systems design.

Model D-1196 is continuously variable 0-25 db with an insertion loss below 0.5 db. The unit features constant attenuation for a given setting. Range is 0-500 MC. Connectors are BNC (N and TNC available). Radar Design Corp., Pickard Drive, Syracuse 11, N. Y.

Circle 281 on Inquiry Card

MICROWAVE EQUIPMENT

Features transistorized modules and ac/dc operation.



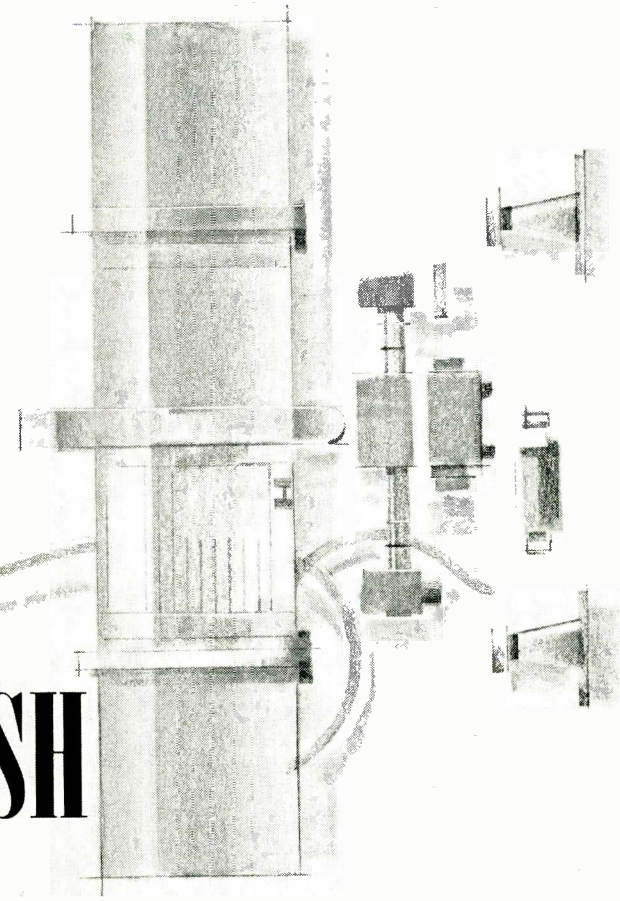
Line includes MR-50 RF equipment; MC-50 multiplex; MT-50 telegraph carrier, and the MA-50 alarm system. All stages are transistorized except the r-f transmitter klystron with life expectancy of 20,000 hrs. of continuous operation. The MR-50 RF unit uses a transmitter AFC with a freq stability of $\pm 0.005\%$. Available in nonstandby, standby, freq. diversity and space diversity models. 600 subcarrier channels of toll quality voice communications are provided through the MC-50 SSB multiplex unit. Motorola Inc., Communications Industrial Electronics Div., 4501 W. Augusta Blvd., Chicago 51, Ill.

Circle 282 on Inquiry Card

Circle 82 on Inquiry Card

Circle 83 on Inquiry Card →

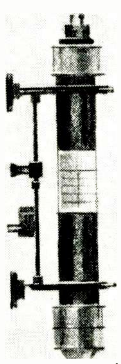
TRAVELING WAVE TUBE PROBLEMS



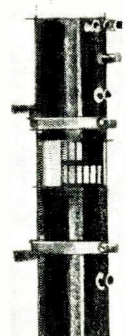
TO FINISH

3 PRODUCTION

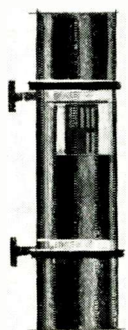
Hughes is now delivering traveling-wave tubes at annual rates that number in the thousands. This outstanding growth results from an ability to transform sophisticated development tubes into production versions rapidly and economically. It also includes the ability to deliver one off-the-shelf item or an entire communications or weapons system tube requirement, numbering in the hundreds, with equal dispatch and reliability of product.



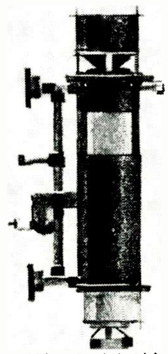
307H 8.5—9.5 kMc; 50 KW Min P_o; 500 W Ave P_o; 54 db Gain; PPM Focused



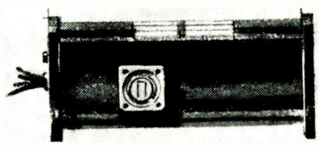
311H 2.0—4.0 kMc; 1 KW Min P_o; 10 W Ave P_o; 36 db Gain; Gridded, PPM Focused



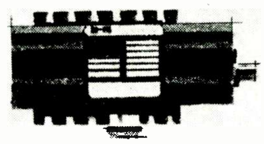
310H 8.5—10.5 kMc; 1 KW Min P_o; 20 W Ave P_o; 40db Gain; PPM Focused



308H 8.6—9.8 kMc; 15 KW Min P_o; 150 W Ave P_o; 53 db Gain Gridded, PPM Focused



346H 7.0—12.4 kMc; 30 mw P_o; PM Focused BWO.



316H 12.4—18.0 kMc; 10—65 mw P_o; PM Focused BWO.

For more information about the production TWT's shown above, or other Hughes tubes, contact your nearest district office.

NORTHEASTERN 4 Federal Street, Woburn, Mass. WEils 3-4824 **EASTERN** 2000 "K" Street, N.W., Washington 6, D. C. FEderal 7-6760; 13 Lloyd Avenue, West Long Branch, N. J., CApital 2-1111 **WESTERN** 11105 South La Cienega Blvd., Los Angeles 45, Calif. SPring 6-1515

CREATING A NEW WORLD WITH ELECTRONICS

HUGHES

HUGHES AIRCRAFT COMPANY

MICROWAVE TUBE DIVISION

TRAVELING WAVE TUBES—*(Continued)*

LITTON INDUSTRIES—*(Continued)*

Type	Description App; Du. Cy.	Freq. (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
L3611	ampl,cw	7–11			ppm	36		20mw
L3612	ampl,cw	7–11			ppm	36		2w
L3497	ampl,.06	1.24–1.4				40		5.5kw
L3634	ampl,cw	9.1–9.5				10		1kw
L3615	ampl,cw	2–4			ppm	36		20mw
L3663	ampl,cw	2–4			ppm	33		10w
L3619	ampl,cw	2–4			ppm	33		20w
L3657	ampl,cw	4–8			ppm	33		10w
L3658	ampl,cw	4–8			ppm	33		20w
L3614	ampl,.01	8–11			ppm	36		1kw

MICROWAVE ELECTRONICS CORP., 4061 Transport St., Palo Alto, Calif.

Type	Description App; Du. Cy.	Freq. (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
M2103N	ampl	2–4		450	ppm	30	10	7mw
M2013Q	ampl	2.3–4.4		450	ppm	30	10	7mw
M2103R	ampl	S–band		450	ppm	30	8	7mw
M2103P	ampl	2–4		450	ppm	30	15	10mw
M2103C	ampl	2–4		450	ppm	30	20	10mw
M2112G	ampl	4–8		900	ppm	30	10	7mw
M2112H	ampl	4–8		900	ppm	30	15	10mw
M2112K	ampl	4–8		900	ppm	30	20	10mw
M2105K	ampl	7–11		1.3k	ppm	30	10	10mw
M2105M	ampl	7–11		1.3k	ppm	30	15	10mw
M2105N	ampl	7–11		1.3k	ppm	30	20	10mw
M2105H	ampl	5.5–11		1.3k	ppm	20	17	10mw
M2105O	ampl	8.2–12.4		1.3k	ppm	25	10	7mw
M2105P	ampl	8.2–12.4		1.3k	ppm	25	15	7mw
M2105Q	ampl	8.2–12.4		1.3k	ppm	25	20	7mw
M2114B	ampl	12.4–18		1.3k	ppm	25	14	7mw
M2114G	ampl	12.4–18		1.3k	ppm	25	20	7mw
M2103M	ampl	2–4		450	600	30	8	7mw
M2103S	ampl	S–band		450	600	30	6	7mw
M2103T	ampl	2.3–4.4		450	600	30	8	7mw
M2103O	ampl	2–4		450	600	30	15	7mw
M2107A	ampl	4–8		900	1k	30	10	7mw
M2107B	ampl	4–8		900	1k	30	15	7mw
M2101J	ampl	7–11		1.3k	1k	30	9	10mw
M2101K	ampl	7–11		1.3k	1k	30	15	10mw
M2101L	ampl	8.2–12.4		1.3k	1k	25	10	7mw
M2101M	ampl	8.2–12.4		1.3k	1k	25	15	7mw
M2114A	ampl	12.4–18		1.3k	1k	25	12	7mw
M2114F	ampl	12.4–18		1.3k	1k	25	17	7mw
M2407G	ampl	4–8		2.5k	ppm	30	35	1w
M2407D	ampl	4–8		2.5k	ppm	30	35	1w
M2407B	ampl	4.5–6.5		2.5k	ppm	30	35	2w
M2407C	ampl	5–6		2.5k	ppm	30	35	5w
M2408C	ampl	4–8		3.6k	ppm	30	35	10w
M2403E	ampl	7–11		2.5k	ppm	30	35	2w
M2403H	ampl	7–11		2.5k	ppm	30	35	2w
M2403O	ampl	7–12.4		2.5k	ppm	30	35	1w
M2403L	ampl	7–12.4		2.5k	ppm	30	35	1w
M2404F	ampl	7–11		3.6k	ppm	30	35	5w
M2404L	ampl	7–11		3.6k	ppm	30	35	10w
M2405B	ampl	12.4–18		3.3k	ppm	30	35	1w
M2405D	ampl	10–20		3.3k	ppm	30	35	1w
M2407A	ampl	4–8		2.5k	800	30	35	1w
M2408B	ampl	4–8		3.6k	1k	30	35	10w
M2403F	ampl	7–12.4		2.5k	1k	30	35	2w
M2404B	ampl	7–11		3.6k	1.3k	30	35	5w
M2404H	ampl	7–11		3.6k	1.2k	30	35	5w
M2404O	ampl	7–11		3.6k	1.2k	30	35	5w
M2404C	ampl	8–12.4		3.6k	1.3k	30	35	5w
M2404I	ampl	8–12.4		3.6k	1.2k	30	35	5w
M2404P	ampl	8–12.4		3.6k	1.2k	30	35	5w
M2404G	ampl	7–10		3.6k	1.25k	30	35	10w
M2404K	ampl	8–11		3.6k	1.25k	30	35	10w
M2404N	ampl	8–9.6		3.6k	1.2k	30	35	10w
M2405A	ampl	12.4–18		3.3k	1.2k	30	35	1w
M2405F	ampl	12.4–18		3.3k	1.2k	30	35	1w
M2207H	ampl	4–8		800	ppm	30	30	20mw
M2201M	ampl	7–11		1.3k	ppm	30	30	10mw
M2301C	ampl	7–11		1.3k	ppm	30	30	100mw
M2201D	ampl	8.2–12.4		1.3k	ppm	30	30	10mw
M2208B	ampl	12.4–18		1.3k	ppm	30	30	10mw
M2207G	ampl	4–8		800	400	30	30	10mw
M2207A	ampl	4–8		800	400	30	30	20mw
M2201A	ampl	7–12.4		1.3k	400	30	30	10mw
M2201K	ampl	7–12.4		1.3k	400	30	30	20mw
M2201B	ampl	8–12.4		1.3k	400	30	30	10mw
M2201E	ampl	8–12.4		1.3k	400	30	30	10mw
M2301D	ampl	7–11		1.3k	400	30	30	100mw
M2208A	ampl	12.4–18		1.3k	400	30	30	10mw
M2204AE		9–10.2		1.3k	400	20		10mw
M2204AF		7.5–8.5		1.3k	400	20		10mw
M2204AG		10.25–10.5		1.3k	400	20		10mw
M2204B		X–band		1.3k	400	25		10mw
M2203B		C–band		900	400	25		10mw
M2203D		5–6		750	400	25		10mw
M2203E		5–6.5		900	ppm	30		10mw
M4301A		24.8–36		3.3k	1.3k			100mw
M2117A		7–11		1.3k	ppm	50	15	10mw

NIPPON ELECTRIC CO., LTD., Tokyo, Japan

Type	Description App; Du. Cy.	Freq. (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
4W75A	ampl,cw	3.6–4.2	6.3,1	3k	ppm	23		2w
4W76A	ampl,cw	3.6–4.2	6.3,1.2	3.2k	ppm	30	27	10w
4W85	ampl,cw	3.7–4.2	6.3,1.5	1k	400	24		1.2w
4W86A	ampl,cw	3.7–4.2	6.3,1.5	2k	400	23		2w
8W76	ampl,cw	6–7.5	6.3,1	3k	ppm	30	27	5w
6W50	ampl,cw	5.8–6.5	6.3,1.1	3.2k	ppm	30	27	10w

NIPPON ELECTRIC CO.—*(Continued)*

Type	Description App; Du. Cy.	Freq. (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
11W17A	ampl,cw	10.7–11.7	6.3,1	2k	ppm	30		1w
LD418	ampl,cw	5.8–6.5	6.3,.5	.85k	700	25	7	15mw
LD550	ampl,cw	5.8–8.2	6.3,.73	3.2k	ppm	33	25	10w
4W80	ampl,cw	3.6–4.2	6.3,.66	2.9k	ppm	30	27	20w
4W27A	ampl,cw	3.6–4.2	6.3,1	3k	300	20		3w

RADIO CORPORATION OF AMERICA, Electron Tube Div., Harrison, N.J.

Type	Description App; Du. Cy.	Freq. (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
A1217	ampl,cw	1.1–1.4		175	sol	20	4.5	.5mw
A1217V6	ampl,cw	1.25–1.35		175	sol	20	4.5	.5mw
A1217V2	ampl,cw	1.4–1.44		175	sol	20	4.5	.5mw
A1217V4	ampl,cw	1.7–2		175	sol	25	5	.5mw
A1207V5	ampl,cw	2.19–2.31		375	sol	20	4.5	1mw
A1207V4	ampl,cw	2.32–2.68		375	sol	25	5	1mw
A1207	ampl,cw	2.7–3.5		375	sol	20	4.5	1mw
A1207V29	ampl,cw	3.5–4		375	sol	25	5	1mw
A1056	ampl,cw	1.1–1.4		175	sol	20	9	.25mw
A1125	ampl,cw	1.35–1.85		175	sol	20	8	.5mw
A1078V10	ampl,cw	2.09–2.41		375	sol	20	8	.25mw
A1078V5	ampl,cw	2.19–2.31		375	sol	22	7.5	.25mw
A1078V7	ampl,cw	2.39–2.71		375	sol	20	7.5	.25mw
A1078V1	ampl,cw	2.5–4		375	sol	20	8	.25mw
6861	ampl,cw	2.7–3.5		375	sol	20	7	.25mw
A1210	ampl,cw	.825–1.4		320	ppm	25	17	10mw
A1139	ampl,cw	1–2		330	sol	20	12	10mw
4019	ampl,cw	1–2		320	ppm	28	17	10mw
A1119	ampl,cw	2–4		420		20	12	1mw
4017	ampl,cw	2–4		475	ppm	30	16	10mw
4020	ampl,cw	4–7		830	ppm	28	18	10mw
A1121	ampl,cw	1–2		550	ppm	25		.1w
A1094	ampl,cw	1.7–2.3		550	ppm	30	28	.2w
4009	ampl,cw	2–4		600	ppm	33		10mw
A1113V8	ampl,cw	2.7–3.5		600	ppm	30		.1w
A1189	ampl,cw	4–7		1.5k	ppm	30		.1w
A1140	ampl,cw	8–12		1.3k	ppm	33		10mw
A1215	ampl,cw	12–15		2k	ppm	30		10mw
4021	ampl,cw	1–2		820	ppm	27		1w
A1097	ampl,cw	2–3.5		2.8k	es	20		2w
4010	ampl,cw	2–4		1.15k	ppm	33		1w
A1244	ampl,cw	2.5–3.8		1.1k	ppm	50		5w
A1205	ampl,cw	4–7		2.5k	ppm	30		1w
A1206	ampl,cw	5.4–11		2.6k	ppm	60		1w
A1188	ampl,cw	7–11		3k	ppm	33		1w
4015	ampl,cw	8–12		3k	ppm	33		1w
A1225	ampl,cw	12–15		4.1k	ppm	30		1w
A1093	ampl,cw	1.7–2.3		2.2k	ppm	27		15w
A1166	ampl,cw	2–4		2.1k	ppm	20		7w
A1160	ampl,.1	2–4		2.2k	ppm	25		10w
A1179	ampl,.1	2–4		3.7k	ppm	23		80w
A1134	ampl,.02	2–4		7.75k	ppm	30		1kw
A1136	ampl,.007	5–6		4.8k	ppm	30		50w
A1181	ampl,.05	7.5–11.2		6.5k	ppm	27		25w

RAYTHEON CO., Microwave & Power Tube Div., Waltham, Mass.

Type	Description App; Du. Cy.	Freq. (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
QK542	ampl	5.9–7.4	6.3,1	1.8k	pm	35		5w
QK622	ampl	2.9–3.1				12		3megw
QK783	ampl	2.7–2.9				12		3megw
QK653	ampl	1.28–1.35		94k		10		5megw
QKS642	amp	1.25–1.35				8.0		10mw
QKW746	amp	5.9–7.4	6.3	600		22	12	10mw
QKW750A	amp	2.9–3.1						60kw
QKW825	amp	5.9–7.4	6.3	1500		33		3w
QKW928	amp	5.9–7.1	6.3	2500	pm	35		10w

SPERRY ELECTRONIC TUBE DIV., Gainesville, Fla.

Type	Description App; Du. Cy.	Freq. (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
STP234	grid,cw	.25–.5	12.6,2.5	590	ppm	37	40	2w
STP108	ampl	12.6,3	2k	750	25			200w
STP256	grid,.5	.3–.6	12.6,2.5	850	ppm	30		1w
STP271	grid,cw	.35–.7	12.6,2.8	1.55k	500	40		200w
STL248	ampl,cw	.5–1	12.6,2.5	2k	500	28		200w
STL257	ampl,cw	.5–1	6.3,2.5	750	ppm	32	40	2w
STL109	grid,.0025	1.27–1.41	35,3.5	24.5k	ppm	34	45	25kw
STL111	ampl,cw	1.1–1.6	6.3,1.8	800	300	24		4w
STL114	ampl,.004	1.1–1.6	4.3,2.1	14k	700	39		7kw
STL135	ampl,cw	1.3–1.43	6.3,3.2	1k	ppm	30	33	2w
STL222	grid,either	1.1–1.8	6.3,3.2	1k	ppm	48	38	2w
STL100	ampl,cw	1–2	12.6,5.2	5.5k	475	42		200w
STL260	grid,.3	1–2	6.3,2.5	1.9k	ppm	50		1w
STL113	ampl,.01	2–3.6	6.3,1.8	8.5k	650	34		1w
STS101	ampl,cw	2–4	6.3,2.6	5.3k	725	43		1.5w
STS284	ampl,cw	2–4	6.3,1	1k	ppm	53	35	1kw
STS288	ampl,cw	2.7–2.9	6.3,1	1k	ppm	53	35	5w
STS276	ampl,cw	3.35–3.65	6.3,1	1k	ppm	53	35	5w
STS181	ampl,.006	2.7–3.3				45		12.5w
STC134	ampl,cw	3.9–5.8	6.3,1.2	2k	ppm	35	35	1.125kw
STC140	ampl,cw	3.9–5.8	6.3,1.2	2k	ppm	43	35	2kw
STC141	ampl,cw	3.9–5.8	6.3,1.2	2.6k	ppm	45	35	5kw
STC124	ampl,.003	4–5.75	6.3,3	11.5k	1.56k			1kw
STC124A	ampl,.003	4–5.75	6.3,3	13k	2k			12w
STC163	ampl,.001	5.2–5.8	6.3,3	17k	1.4k		35	5w
STC119	ampl,.01	5.4–5.9	6.3,2.2	13k	1.7k	30		2kw
STC164	ampl,cw	5.4–5.9	6.3,3	2.8k		40		10w
STC174	grid,cw	5.4–5.9	6.3,3	2k	ppm	55		.25w
STC152	ampl,.002	5.4–5.9	6.6,3	15.2k	1.85k	27		50w
STC236	ampl,cw	5.9–8.2	6.3,.75	2.6k	ppm	35	28	175w
STC279	ampl,cw	5.4–5.9	10.7,4	1.35k	ppm			1w
STC278	.01	5.4–5.9	6.3,4.2	5.4k	ppm	35		50w
STX104	ampl,cw	7–8.5	6.3,3.4	8k	1.1k	30		175w
STX296	ampl,cw	5.4–11	10.7,1.2	2.2k	ppm			1w

(Continued on page 166)

look into Panoramic's new SPA-4a exclusive features for more reliable spectrum analysis 10 mc to 44,000 mc

2 to 4 TIMES THE USABLE SENSITIVITY

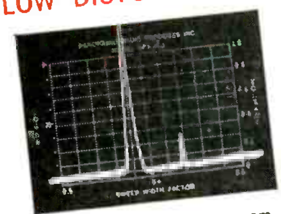
Lower internal noise enables analysis of even smaller signals than before (see chart)... accurate measurement of more highly dispersed energies, as typified by extremely narrow pulsed signals.

BAND	RF SENSITIVITY*
1- 10 – 420 MC	–100 to –110 dbm
2- 350 – 1000 MC	– 95 to –105 dbm
3- 910 – 2200 MC	–100 to –110 dbm
4- 1980 – 4500 MC	– 90 to –100 dbm
5- 4.5 – 10.88 KMC	– 90 to –100 dbm
6-10.88 – 18.0 KMC	– 85 to –100 dbm
7- 18.0 – 26.4 KMC	– 70 to – 90 dbm
8- 26.4 – 44.0 KMC	– 60 to – 85 dbm

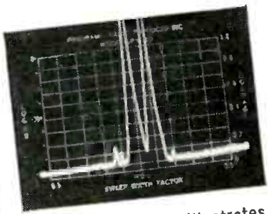
*measured when signal and noise equal 2x noise

EXCEPTIONALLY LOW DISTORTION

Reduced threshold allows SPA-4a to operate at smaller input signal levels (and attenuated larger ones). Unretouched screen photos show how this permits virtually spurious-free measurement—over a wide dynamic range—of harmonics, in-band distortion, and other weak signals in the presence of strong ones.



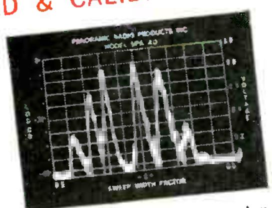
Extended dynamic range comparison of 2 signals on SPA-4a. Larger is + 15 db over full scale log. Smaller is at –28 db on scale or –43 db from larger. Note exceptional freedom from spurious. (Photo not retouched)



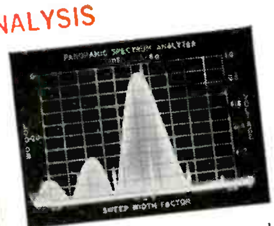
Distortion analysis illustrates SPA-4a wide range linearity. Odd-order distortion here is measured more than 50 db below level of 2 main tones (deflected 20 db above full scale). Photo unretouched.

HIGHLY RESOLVED & CALIBRATED ANALYSIS

Reduced internal hum improves resolution of closely spaced signals; also improves minimum dispersions for more highly magnified analyses. Marker modulation permits highly accurate measurements of frequency differences during high speed analysis. See photos.



Narrow band 20 kc dispersion analysis shows unique resolution capability. Here, a 1000 mc FM signal with 2 kc modulation is seen near first carrier null. Photo unretouched.



Pips of internal marker and sidebands (ext. mod. ≈100 kc) accurately measure pulse width in spectrum of 10μs. radar pulse. Upper lobes seen to be very small. (Unretouched)

dependable CERTIFIED SPECIFICATIONS for accurate data

Important as these advantages are, there are many more.

The SPA-4a's exclusive features also include:

1. ONE TUNING HEAD – 10 mc to 44,000 mc, utilizing 3 stabilized, low hum local oscillators (1 HF triode and 2 klystrons). Fundamentals to 11 kmc. Direct reading with ± 1% accuracy.
2. TWO INDEPENDENT FREQUENCY DISPERSION RANGES: Continuously adjustable; 0-70 mc with exceptional flatness, stable 0-5 mc for narrow band analysis. Both swept local oscillators operate on fundamentals only for spurious-free analysis.
3. PUSH-BUTTON FREQUENCY RANGE SELECTOR.
4. ADJUSTABLE IF BANDWIDTH 1 KC to 80 KC.
5. 3 CALIBRATED AMPLITUDE SCALES – 40 db log, 20 db lin, 10 db power.
6. SYNCHROSCOPE OUTPUT WITH 40 DB GAIN.
7. SWEEP RATE ADJUSTABLE FROM 1-60 CPS. May be set free running, synchronized to the line or to external prf. Also provisions for sweep rate calibrations.

Easy to use, too... human engineered for simple operation, component accessibility.

The advanced new SPA-4a is unmatched for visually analyzing FM, AM and pulsed signal systems—instabilities of oscillators—noise spectra—for detection of parasitics—studies of harmonic outputs, radar systems and other signal sources.

Write, wire, phone today for detailed SPA-4a specification bulletin and new Catalog Digest.

Sec. 2900

Panoramic ELECTRONICS, INC.

Formerly Panoramic Radio Products, Inc.

the pioneer is the leader

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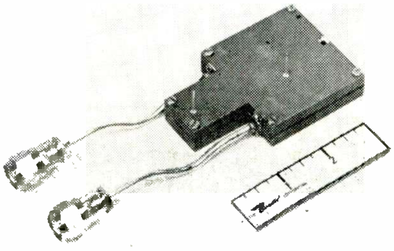
PANORAMIC ELECTRONICS, INC.
540 South Fulton Avenue, Mount Vernon, N. Y. • Phone: OWens 9-4600
TWX: MT-V-NY-5229 • Cables: Panoramic, Mount Vernon, N. Y. State

Circle 84 on Inquiry Card

New Products

SOLID-STATE SWITCH

Dissipative type, nsec. switch for operation at 4300 MC.

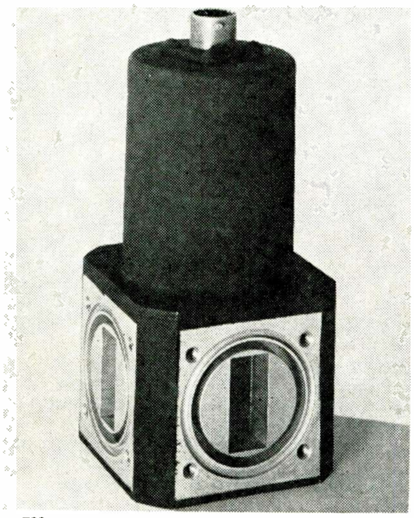


This solid-state microwave switch has been developed for C-band usage. A lightweight, small volume strip transmission line configuration provides isolation greater than 20 db with insertion loss less than 1.5 db over a 6% bandwidth. Over this same bandwidth, vswr's of less than 1.5:1 can be realized. Switch times less than 5 nsec. have been observed using suitable driving sources. The Bendix Corp., Bendix-Pacific Div., 11600 Sherman Way, N. Hollywood, Calif.

Circle 351 on Inquiry Card

WAVEGUIDE SWITCH

Covers the freq. range from 5.85 to 18 gc.

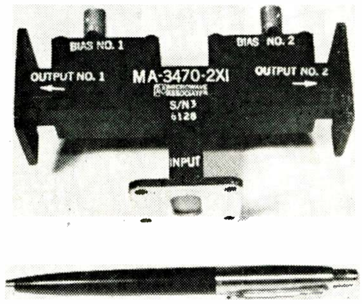


Illustrated is the X-band switch for use with RD67/U guide. It has a max. vswr of 1.10:1, min. isolation of 50 db and 0.10 db insertion loss, and 250 kw peak power handling capability at 1 atmosphere from 8.5 to 9.6 GC. The RG67/U switch can be pressurized to 45 psi and is driven by a "fail safe" solenoid drive that operates from either 28 vdc or 110 vac. NRK Microwave Div., Cook Electric Co., 4601 W. Addison St., Chicago, Ill.

Circle 352 on Inquiry Card

WAVEGUIDE SWITCH

It features long life, lightweight and high reliability.

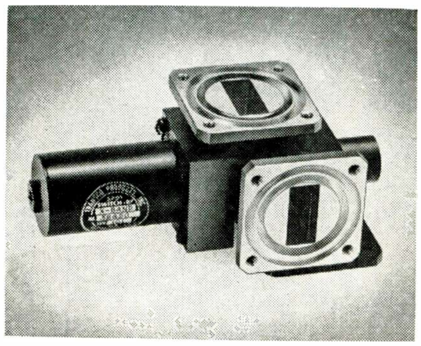


High-speed, all-solid-state waveguide switch, the MA-3470 2X1, is a rugged, compact unit for microwave applications in which ultra-fast switching (typically 2 nsec.) is desired. It is available as a SPDT unit for operation at X-band (9200 MC to 9600 MC). A major advantage is the low driving power required (approximately 75 mw). Insertion loss in the "closed" position is 4.5 db max., and isolation of 60 db min. is provided in the "open" condition. It will handle 150 w. peak power, and up to 4 w. CW. Microwave Assoc., Inc., Burlington, Mass.

Circle 353 on Inquiry Card

WAVEGUIDE SWITCH

Offers long life, ability to switch under power and fast switching time.



Other features of the Transprobe[R] are the small size and low actuating power. Actuator current at 28 vdc is 0.7 a. r-f switching time is less than 10 msec. Switches will meet military environmental requirements. Typical specs. for a SPDT, X-band, Transprobe are: Freq.—8.2—12.4 GC; vswr — 1.25 max.; Insertion loss — 0.25 max.; r-f power—10 kw peak, 10 w. average (250 kw peak, 160 w. average can be supplied); and Switching time —50 msec. max. Transco Products Inc., 12210 Nebraska Ave., Los Angeles, Calif.

Circle 354 on Inquiry Card

SPERRY ELECTRONIC TUBE DIVISION **microwave memo**

Sperry adds high-power pulsed TWT's to list of tubes available in 30 days

In a move to simplify design problems in present and future radar systems, Sperry Electronic Tube Division of Sperry Rand Corporation has added two high-power pulsed traveling wave tubes to the list of advanced microwave tubes available in 30 days.

The two tubes covered by the announcement—the STL-114 and the STC-152—operate in L and C bands, respectively. They are typical of a line of pulsed TWT's ranging from P through V bands which Sperry offers on a firm delivery date basis.

EASY RADAR APPLICATION

Sperry's pulsed TWT's are admirably suited to the demands of application in phased array radars, height finders, search, ECM, and other radar applications. Widely varied in-system experience has proved that their reliability, long life, high power, high gain, and extreme broadband operation make them ideal for radar use.

Design features of this tube family minimize the necessity for system adjustments in the field. Among these features are broadband response, constant voltage operation, and short circuit stability.

VERIFIED RELIABILITY

These pulsed TWT's, produced at Sperry's Great Neck, N. Y., facility, have compiled an impressive record of in-system experience. Such experience has proved that their resistance to shock and vibration damage, their inherent indifference to ambient conditions, and their mounting flexibility make them ideal for ground or airborne application.

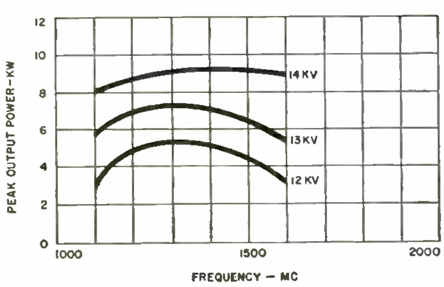
Place your order with your Cain & Company representative. His phone number appears in the adjacent column. Tubes are available within 30 days after receipt of order.

FREE TECHNICAL INFORMATION on the Sperry line of high-power pulsed traveling wave tubes may be obtained by writing to Sec. 404, Sperry Electronic Tube Division, Gainesville, Florida.

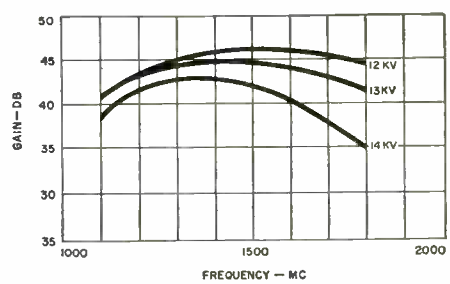
V BAND CAPABILITY

Among Sperry's other interesting activities in pulsed TWT's is the extension of capability into the V Band —26.5 to 40.0 kMc. Although these efforts are largely classified, inquiries are invited from those who have the necessary clearance and need to know.

FACTORY ALIGNMENT of a Sperry TWT within its focusing solenoid greatly simplifies field maintenance. Once this operation has been performed by a skilled Sperry technician, the assembly is self-aligning.



Typical saturated power output vs. frequency for a pulsed Sperry TWT.



Typical small signal gain vs. frequency for a pulsed Sperry TWT.

SPERRY ELECTRONIC TUBE DIVISION
GAINESVILLE, FLA. / GREAT NECK, N. Y.
SPERRY RAND CORPORATION

MICROWAVE ELECTRON DEVICES

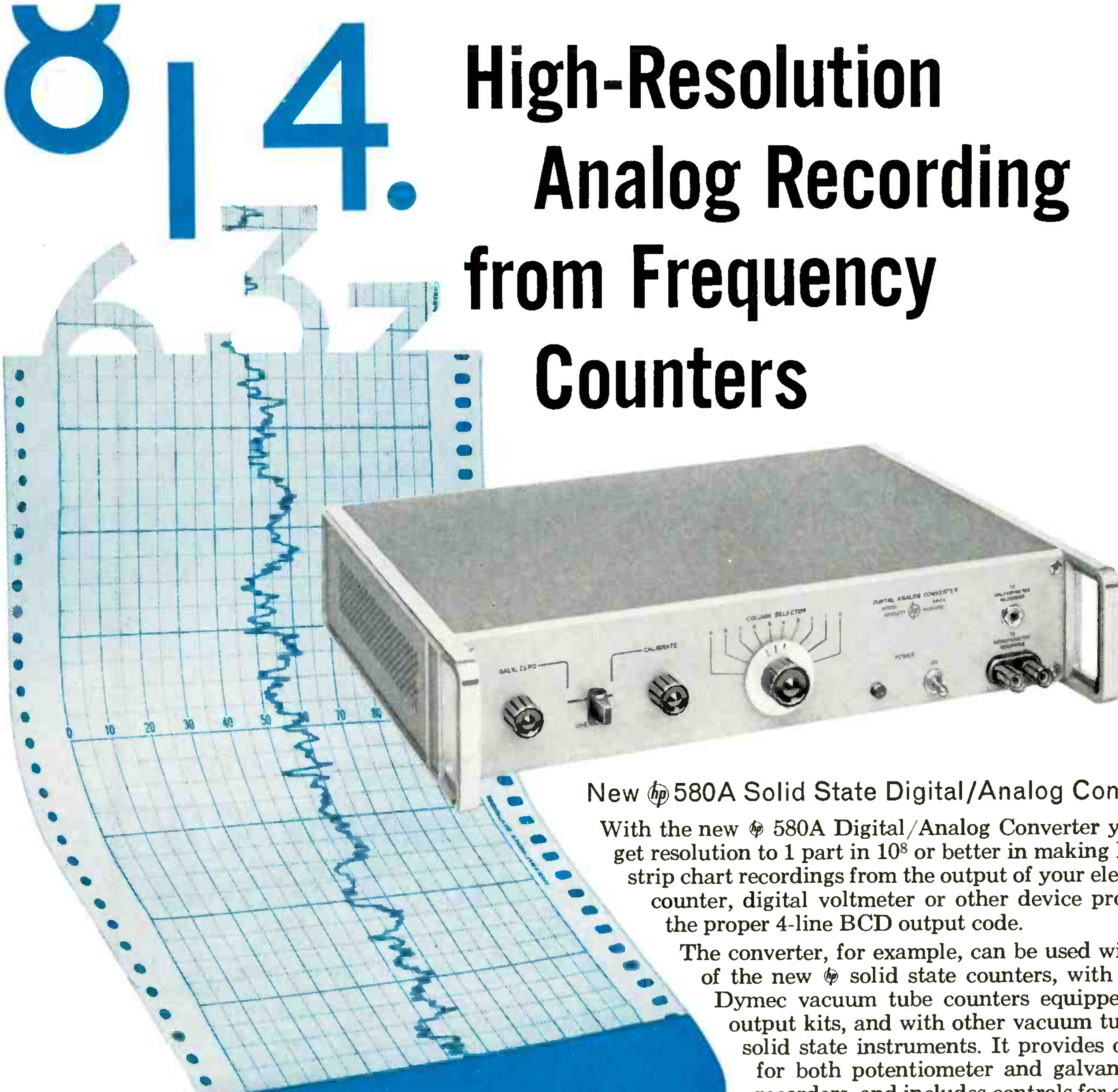
TRAVELING WAVE TUBES—*(Continued)*

Type	Description App; Du. Cy.	Freq. (kmc)	Heater V;A	Helix V	Foc. Fld. (Gauss)	Gain (db)	Noise Fig. (db)	Power Output
SPERRY ELECTRONICS TUBE DIV. —*(Continued)*								
STX77	grid,cw	7–11	10.5,1.05	5k	1k	37		10w
STX186	ampl,cw	7–11	6.3,3	4k	ppm	32	40	10w
STX187	ampl,cw	7–11	6.3,3	4k	ppm	35	40	20w
STX105	ampl,cw	8.65–11	6.3,3.4	8k	1.4k	30		175w
STX182	ampl,cw	8–12	6.3,1.5	3.2k	ppm	35	35	30w
STANDARD TELEPHONES & CABLES, LTD., Brixham Road, Paignton, Devon								
W5/1G	ampl,cw	5–8	6.3,.85	2.9k	ppm	38	27	10w
W7/3G	ampl,cw	3.6–4.2	6.3,.85	3k	ppm	26	27	10w
W7/4G	ampl,cw	3.6–4.2	6.3,.85	2.9k	ppm	42	27	10w
W9/1E	ampl,cw	2.5–4.1	6.3,.95	420	pm/sol	28	21	120mw
W9/2E	ampl,cw	2.5–4.1	5,.55	400	sol	40	10	10mw
W9/3E	ampl,cw	2.5–4.1	6.3,.6	200	pm/sol	15	16	.3mw
W10/3E	ampl,cw	2.7–3.3	5,.6	450	sol	23	6.7	3mw
W13/1D	ampl,cw	1.5–3				40		30w
SYLVANIA ELECTRIC PRODS., Special Tube Operations, Mountain View, Calif.								
6752	ampl,cw	1–2	6.3,1.5	1k	600	33		2w
TW4268	ampl,cw	1–2	6.3,1.5	800	ppm	30		1w
TW4267	ampl,cw	1–2	6.3,1.5	400	ppm	35		15mw
TW4007	ampl,cw	1–2	6.3,1.5	800	ppm	30		1w
TW4006	ampl,cw	1–2	6.3,.96	400	ppm	35		15mw
TW620A	ampl,cw	1–2	6.3,1.5	1k	400	33		2w
TW538	ampl,.01	1–2	6.3,3.5	10k	600	35		1kw
TW956L	ampl,cw	2–4	6.3,1.7	1k	ppm	37		2w
6559	ampl,cw	2–4	6.3,1.5	1k	850	33		2w
TW4260	ampl,cw	2–4	6.3,1.5	1k	ppm	30		1w
TW4261	ampl,cw	2–4	6.3,1.5	500	ppm	35		10mw
TW4002M	ampl,cw	2–4	6.3,1.7	500	ppm	35		10mw
TW534B	ampl,cw	2–4	6.3,1.5	1k	750	33		2w
XTW4278	ampl,cw	4–8	6.3,1.7	3k	ppm	30		1w
XTW4281	ampl,cw	4–8	6.3,1.5	1k	ppm	35		10mw
XTW4273	ampl,cw	7–12.5	6.3,1.7	4k	ppm	30		1w
TW591	ampl,.002	8–10.6	6.3,2	10k	2.8k	36		1kw
TW622	ampl,plsd	8–11	6.3,1.5	4k	1.05k	33		2w
XTW4282	ampl,cw	8–12	6.3,1.5	1.4k	ppm	35		5mw
VARIAN ASSOCIATES, Tube Div., Palo Alto, Calif.								
VA121B	ampl,.01	2–4		2.25k		30		40w
VA125A	ampl,.002	2.65–2.97		120k				2mw
VA125B	ampl,.002	2.92–3.25		120k				2mw
VA126	ampl,.002	5.4–5.9		130k				3.3mw
VA128	ampl,.003	2.7–3.5		14.5k		34		5kw
VA131	ampl,.004	1.15–1.55		25k		45		50kw
VA132	ampl,cw	0.5–1		2k				200w
VA133	ampl,.066	1.254–1.386		12k		50		5kw
VA601	ampl,cw	1–2		2k	ppm			50w
VA134	ampl,plsd				ppm	45		5kw
WATKINS-JOHNSON CO., 3333 Hillview Ave., Palo Alto, Calif.								
WJ221	ampl,cw	.25–.5	6.9,.65	50	1000	25	3.5	
WJ212	ampl,cw	1–2	4.5,.8	140	1000	25	4	
WJ212-1	ampl,cw	1.1–1.6	4.5,.8	140	1000	25	3.6	
WJ211	ampl,cw	2–4	3.5,.65	175	1000	25	4.3	
WJ211-1	ampl,cw	2.1–2.4	3.5,.65	175	1000	25	3.5	
WJ211-2	ampl,cw	2.3–2.7	3.5,.65	175	1000	25	3.4	
WJ211-3	ampl,cw	2.5–3.5	3.5,.65	175	1000	25	3.9	
WJ217	ampl,cw	2–4	6.3,.75	1.8k	ppm	40		12w
WJ227	ampl,cw	2–4	6.3,.76	1.6k	ppm	40		12w
WJ206	ampl,.01	8.4–9.4	12.5,4	28kvp	ppm	43		10kw
WJ218	gen,cw	2–4	7.25,.5	265	ppm			2mw

PARAMETRIC AMPLIFIERS

Type	Description Application	Frequency (kmc)	Band-width	Gain (db)	Pump Freq (kmc)	Pump Power (mw)	Noise Fig. (db)	Power Output
KEARFOTT DIV., General Precision, Inc., Oxnard St., Van Nuys, Calif.								
	ampl	.8–1.2		10	3.5	150	3.5	
MOTOROLA, Scottsdale, Ariz.								
SPA01	ampl	2.48–2.52	70mc	17	11.3–11.7	150	4	
LPA01	ampl	.18–.27	1.5mc	16	1.2–1.6	1	1.5	
LPA02	ampl	.4–.46	3mc	13	1.4–1.55	1.5	2	
NIPPON ELECTRIC CO., LTD., Tokyo, Japan								
RPO-2G-2A	ampl	1.7–1.85	12mc	17	7.85–8	80	3	3dbm
RADIO CORPORATION OF AMERICA, Electron Tube Div., Harrison, N.J.								
SS500	t-d ampl	1.275–1.325	50mc	15	dc	10ma	6	0dbm
SS100V1	ampl	2.19–2.21	20mc	17	3	400	6	–20dbm
RAYTHEON CO., Microwave and Power Tube Div., 130 Second Ave., Waltham 54, Mass.								
PKDe-1	ampl	13.5	10mc	20	27	50	2.5	
PNS-1	ampl	2.7–2.9	20mc	17	X-band	50	2.5	
SFD LABORATORIES, INC., 800 Rahway Ave., Union, N.J.								
SFD902	ampl	5.4–5.9	25mc	17	17.8	135	3.5	
ZENITH RADIO CORP., 6001 West Dickens Ave., Chicago 39, Ill.								
LB	ampl	.3–1.5	8%	20	2f	100mw	.8–1.5	20mw

High-Resolution Analog Recording from Frequency Counters



New 580A Solid State Digital/Analog Converter

With the new 580A Digital/Analog Converter you can get resolution to 1 part in 10^8 or better in making X-Y or strip chart recordings from the output of your electronic counter, digital voltmeter or other device providing the proper 4-line BCD output code.

The converter, for example, can be used with any of the new solid state counters, with and Dymec vacuum tube counters equipped with output kits, and with other vacuum tube and solid state instruments. It provides outputs for both potentiometer and galvanometer recorders, and includes controls for calibration of the recorders.

Any three successive digits (or the right-hand two) may be chosen for analog output, and selection of the least significant digits produces analog records of extreme resolution and accuracy. For example, recording three righthand digits of nine-column data results in resolution of 1 part in 10^8. Automatic zero-shift keeps the record "on-scale" at all times.

The solid state 580A accepts 4-line data, which is transferred to storage binary units within the converter on command from the counting source. The stored data is then translated and weighted to provide the proper analog output voltage or current.

SPECIFICATIONS

Accuracy:	0.5% of any three-digit portion of input.
Resolution:	0.25% of any three-digit portion of input.
Potentiometer Output:	100 mv full scale
Galvanometer Output:	0 to 1 ma into 5,000 ohms or less
Driving Source:	Parallel entry 4-line BCD, 1-2-2-4 (9 digits max.) having a swing of 4 to 75 v about a source reference "O" state which may be up to 100 v above or below ground.
Command Pulse:	Positive or negative pulse, 20 μsec or greater in width, 6-40 v amplitude
Transfer Time:	2 msec
Size:	16¾" wide, 3½" high, 11½" deep; 15 lbs.
Price:	$500.00

Data subject to change without notice
Price f. o. b. factory.

HEWLETT-PACKARD COMPANY
1094B Page Mill Road, Palo Alto, California, U.S.A.
Cable "HEWPACK" DAvenport 6-7000
Sales representatives in all principal areas

HEWLETT-PACKARD S. A.
Rue du Vieux Billard No. 1, Geneva, Switzerland
Cable "HEWPACKSA" Tel. No. (022) 26. 43. 36
7368

Circle 23 on Inquiry Card

SPERRY ELECTRONIC TUBE DIVISION

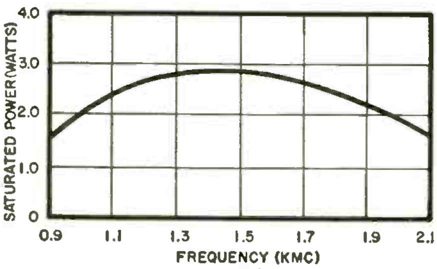
microwave memo

Sperry extends 30-day delivery to cover ECM and augmenter TWT's operating in L, S, and X bands

In a dramatic extension of its capability for delivering high-performance microwave tubes on short notice, Sperry Electronic Tube Division has added three system-proved traveling wave tubes to the list of those available in 30 days. Included in the move are tubes operating in L, S, and X bands. They cover a frequency range 1.1 to 11.0 kMc.

APPLICATION FLEXIBILITY

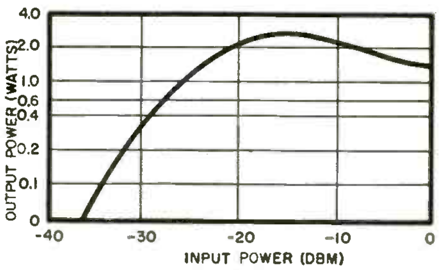
The tubes in this series are particularly suited to application in augmenters and ECM equipment. The inherent broadband characteristic and unusual ruggedness of these PPM focused tubes makes them unusually versatile in airborne applications. A full course of MIL and environment tests, as well as considerable in-system experience have verified these characteristics.



A typical saturated power versus frequency curve for an L band Sperry TWT.

INCREASED POWER POSSIBLE

Although these tubes nominally operate in the 1-2 watt power output range, optimum tuning can increase power to as much as 5 watts. A high-mu control grid adds to the versatility of these tubes by allowing remote switching, modulation control and gain adjustment.



Drive characteristics at mid-band for a typical Sperry ECM/augmenter TWT.

SYSTEM DESIGN SIMPLIFIED

Use of these Sperry tubes greatly simplifies system design problems. Low voltage and high gain reduce power supply requirements. Application is further simplified, since ambient cooling is sufficient in most applications and the tubes may be mounted in any position.

For FREE technical information on these Sperry Traveling Wave Tubes, write to Section 403, Sperry Electronic Tube Division, Gainesville, Florida.

The L-Band tube is priced at $1,900., the S-Band tube at $2,195., and the X-Band at $2,540.

For application assistance and quotation, consult your nearest Cain & Co. representative. His address and phone number appear on the opposite page.

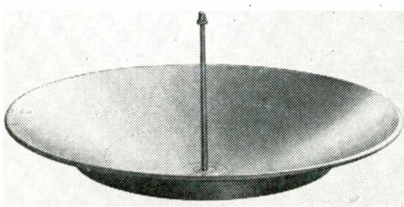
SPERRY ELECTRONIC TUBE DIVISION

GAINESVILLE, FLA. / GREAT NECK, N. Y.
SPERRY RAND CORPORATION

New Products

MICROWAVE ANTENNAS

Common carrier antennas feature good gain, pattern and performance.

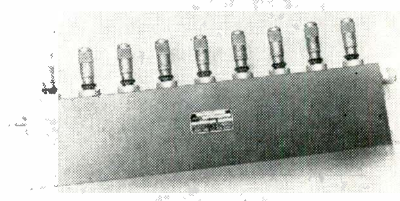


Inputs are waveguide flange selected to mate with customer requirements and bleeder ports are provided to permit pressurization of the feed. Vibration dampening is obtained by guying. Taper feed is available with 8 and 10 ft. reflectors; button hook feed may be ordered with 6, 8 and 10 ft. models. Freq. range covered by these antennas is from 3700 to 4200 MC. Technical Appliance Corp., Sherburne, N. Y.

Circle 279 on Inquiry Card

BANDPASS FILTER

This 9 section tunable features steep skirt selectivity.



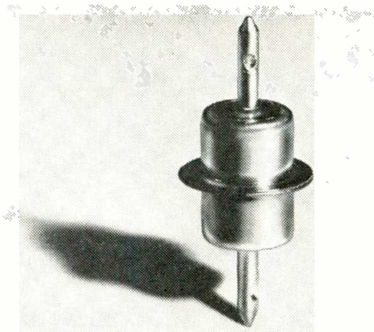
Tunable over a freq. range of 2200-2300 MC, the filter has a rejection bandwidth of 40 and 86 MC at 3 db and 50 db respectively. Insertion loss of the unit is 1.0 db max. and input vswr with matched load is 1.3:1. The filter is multiple-tuned with individual micrometer heads for each cavity. Type N connectors are used for both input and output connections. Frequency Engineering Labs., P. O. Box 504, Asbury Park, N. J.

Circle 280 on Inquiry Card

New Products

MICROWAVE MADT's

They have operated at 3500 MC and are for use at 2000 MC in amplifiers.

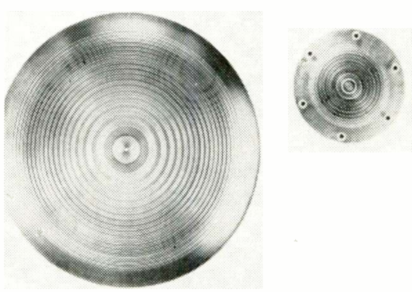


The devices typically have a power gain of 8 db min. at 1000 MC. At this freq. it is possible to obtain over 10 mw of output power. At 1000 MC the units also provide a 10.5 db noise figure, typically. The package is a hermetically sealed, coaxial type with holder matched for direct insertion into a 50ω coaxial network. Tentative specs: VCBO—20 v.; VCES—20 v.; VEBO—0.4 v.; Storage temp.—100°C; Total device dissipation, @ 25°C, 80 mw. Philco Corp., Lansdale Div. Lansdale, Pa.

Circle 283 on Inquiry Card

FRESNEL ZONE PLATES

Feature low loss, light weight and freq. range from 70 to 3000 GC.



Fresnel zone plates, which have been used in the past at optical freq. are now available for use at millimeter wavelengths. These phase-correcting plates produce focusing and collimating effects similar to those of conventional parabolic reflectors and dielectric lenses. Fresnel zone plates offer the following additional advantages of economy and large apertures. In production quantities zone plates can be molded, resulting in uniform antennas at low cost. Research Div., Electronic Communications, Inc., 1830 York Rd., Timonium, Md.

Circle 284 on Inquiry Card

NEW UNIVERSAL SPECTRUM ANALYZER

***NOW AVAILABLE WITH VARIABLE RESOLUTION 2 TO 80 kc**

Polarad Model SA-84W being used to make pulse analysis of radar aboard a Pan American Boeing 707, Jet Clipper®

MODEL SA-84W 10 to 44,000 MC in a single unit

FEATURES:

A Over 80 mc dispersion
1 mc to over 80 mc for narrow pulse analysis.

100 kc to 7 mc for wide pulse analysis.

A Dual [illegible]
7 k[illegible] automatically [illegible] dispersion cont[illegible]l.

B Crystal controlled markers from 10 to 44,000 mc.

C Provision for use with a multi-pulse spectrum decoder (Polarad Model SD-1)

D Log-linear amplifiers

E Expanded, direct-reading, slide rule dial.

F Accurately calibrated IF attenuator

The Polarad Model SA-84W is the most accurate universal microwave analyzer to measure nearly all parameters — Pulse, CW, FM, VSWR, antenna patterns, bandwidths and filter characteristics.

FREE LIFETIME SERVICE ON ALL POLARAD INSTRUMENTS

MAIL THIS CARD for specifications. Ask your nearest Polarad representative (in the Yellow Pages) for a copy of "Notes on Microwave Measurements."

POLARAD ELECTRONICS CORPORATION

43-20 34th Street, Long Island City 1, N. Y.
Representatives in principal cities.

POLARAD ELECTRONICS CORPORATION: 123456

POLARAD

Please send me information and specifications on:

☐ Model SA-84W Universal Spectrum Analyzer
☐ Model SD-1 Multi-Pulse Spectrum Selector (see reverse side of page)

My application is ______________________

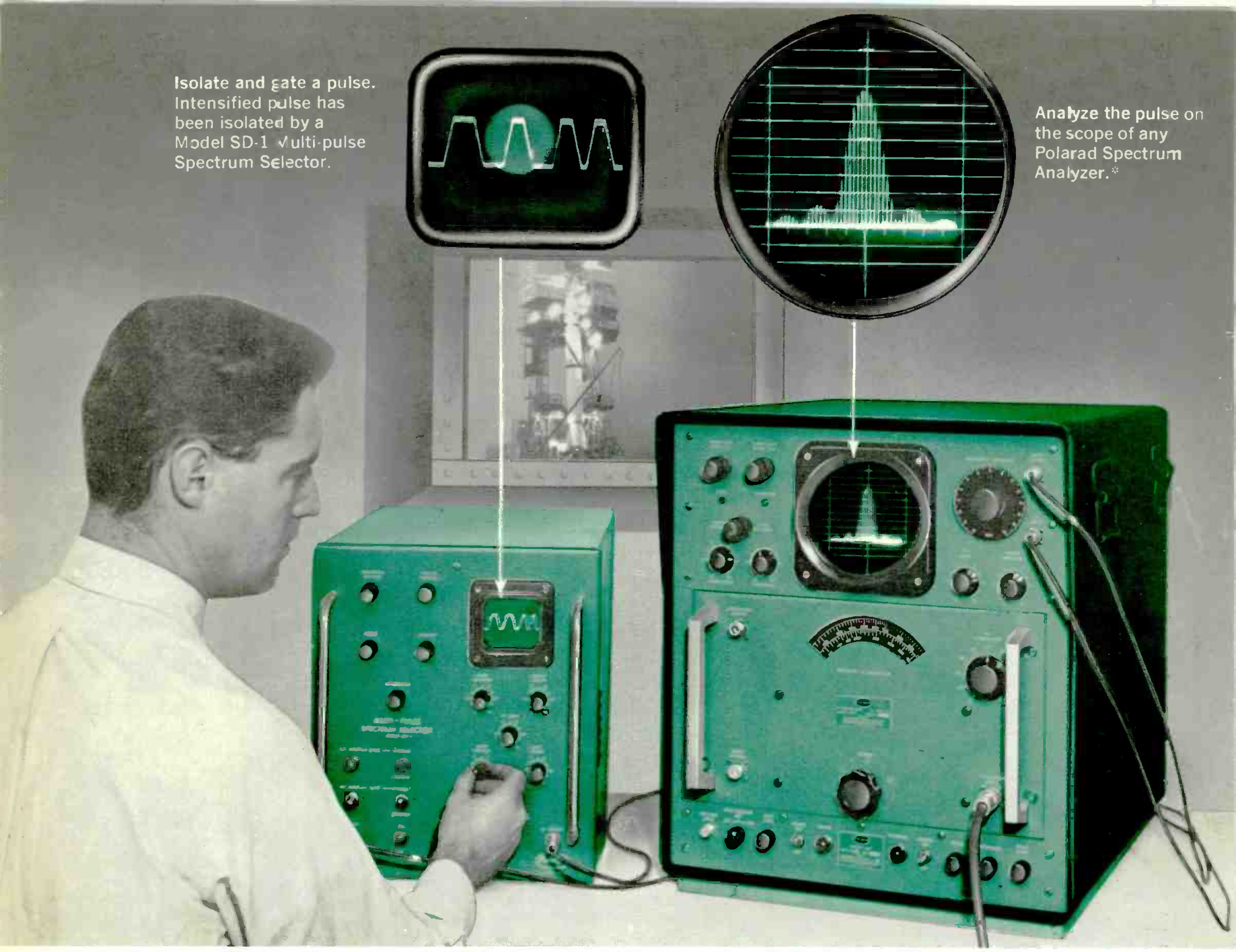
Name ______________________

Title ______________ Dept. ______________

Company ______________________

Address ______________________

City ______________ Zone ______ State ______



COMPLEX SPECTRUM DECODING

10 to 44,000 mc.

Signal Analysis for Missiles, Telemetry, IFF, Beacons and Radar

The Polarad spectrum selector permits spectrum analysis and decoding of any selected pulse within a multiple pulse train. Sweep, gate width and position can be controlled. Model SD-1 permits the selection and gating of a group of pulses up to 180 μsec. in length (Model SD-IX permits 350 μsec.)

Works with POLARAD Models TSA, TSA-S, TSA-W, SA-84 and SA-84W spectrum analyzers.

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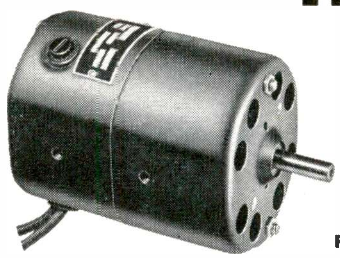
LONGER BRUSH LIFE!
NO STALLS! HOWARD



MODEL 243

UNIVERSAL and
DC MOTOR
1/200 to 1/8 H. P.

For Business Machines
Vending Machines • Money Changers
Gear Applications

Broached brush holders hold close tolerances for brush alignment, to give increased brush life! Self-aligning sleeve-type bearings with finger-type pressure plates for uniform alignment and extra-heavy stamped steel housing assure smooth performance. Won't stall even with heavy jarring!

Write for details and prices!

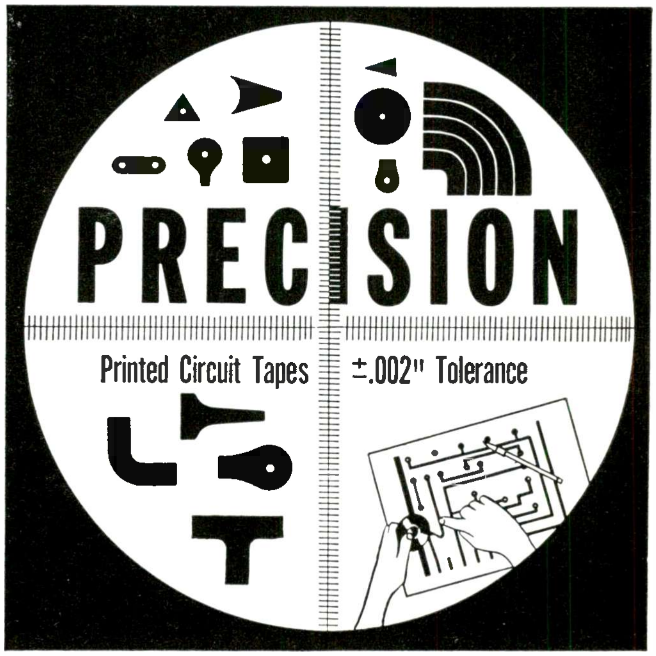
LENGTH: 3-15/16" DIAMETER: 2-17/32"

H.P. Continuous:		Series—1/12 @ 10,000 RPM Shunt—1/20 @ 5,000 RPM
Intermittent:		Series—1/8 @ 10,000 RPM Shunt—1/12 @ 5,000 RPM
FULL LOAD SPEED		Series—5,000 to 10,000 Shunt—2,000 to 7,000
VOLTAGES		Series—12 to 230V AC/DC Shunt—6 to 120V DC

Divisions:
Electric Motor Corp. Cyclohm Motor Corp. Loyd Scruggs Co. Racine Electric Prod.

HOWARD INDUSTRIES, INC. • 1730 State Street • Racine, Wisconsin

Circle 93 on Inquiry Card



Brady's **All-New** printed circuit tapes and shapes assure uniform, accurate layouts — sharp, clean outlines. Made of Brady's new B-225 see-thru red tape. Card-mounted for fast application. Matching connector strips in rolls with .002" tolerance. Write for bulletin and FREE samples. 110A

W. H. BRADY CO. • 750 W. Glendale Ave. • Milwaukee 9, Wis.
Manufacturers of Quality Pressure-Sensitive Industrial Tape Products • Est. 1914

Circle 94 on Inquiry Card

NEW DAVIES PLATING CONSOLE

Why laboriously assemble your own installation for plating printed circuits, electronic components and precious metals—when you can have a Davies self-contained console?

Just set the Davies Console in position, make one power, water and drain connection—and start plating.

Nothing else to do, because Davies did it all—tank construction, coating, internal utilities . . . the works.

Write today. Tell us your R&D or production needs. We'll offer design suggestions, free.

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St. Louis 16, Mo.

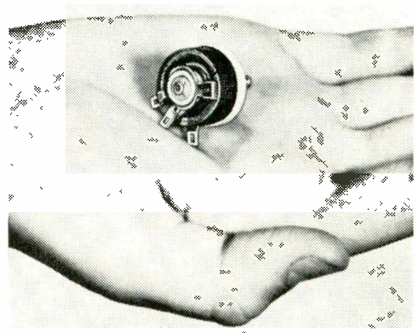
Branches: 814 W. 17th St. Kansas City 8, Mo. — 2547 Farrington Dallas 7, Texas — 1395 W. Quincy Englewood, Colo.

Circle 95 on Inquiry Card

New Products

MINIATURIZED RHEOSTAT

For use in both military and commercial applications.

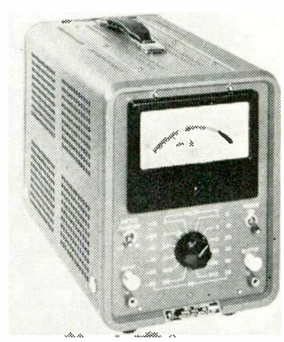


Streamlined R-12½ w. power rheostat is available in both standard and special requirements. Special shafts and bushings, custom taper windings and variations in other characteristics are available as specified in this new power rheostat. Tru-Ohm Products, 3426 W. Diversey Ave., Chicago 47, Ill.

Circle 285 on Inquiry Card

TRUE RMS VOLTMETER

Provides a 1% midband accuracy and 100 μa max. sensitivity.



Model 910A True RMS Voltmeter also has a 10 CPS to 7 MC bandwidth for measuring true RMS value of virtually all waveforms. For added versatility an amplifier output has been provided for simultaneous oscilloscope or recorder monitoring. It also features: high input impedance, high sensitivity, and fast response. Some of the measurement applications recommended include: nose and microphonics, total harmonic and intermodulation distortion, RMS ripple voltage, and currents and losses in transformers, coils, ferrite cores, capacitors, etc. John Fluke Mfg. Co., Inc., P. O. Box 7428, Seattle 33, Wash.

Circle 286 on Inquiry Card

WHY THINK BIG?

CENTRALAB
"TWO-DIMENSIONAL"

PEC®

TRIMMER RESISTORS

AS SMALL AS

1/4" x 1/4"

WITH VIRTUALLY NO DEPTH!

All the adjustment you need—in a fraction of space, at a fraction the cost—for military or commercial applications.

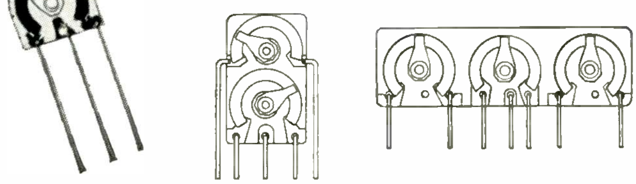
These versatile ceramic base units are available as single or multiple trimmers. Fixed resistors can be included on multiple units—either associated with, or independent of the trimmer circuitry, through the flexibility of the PEC technique. They can be supplied in all standard resistance values.

MICRO-MINIATURE (SERIES 3)

ACTUAL SIZE

Single trimmer measures only 0.250" square, 0.100" deep, rated at .05 watts at 70° C. Multiple trimmers can include up to 5 fixed resistors, depending upon value and voltage rating.

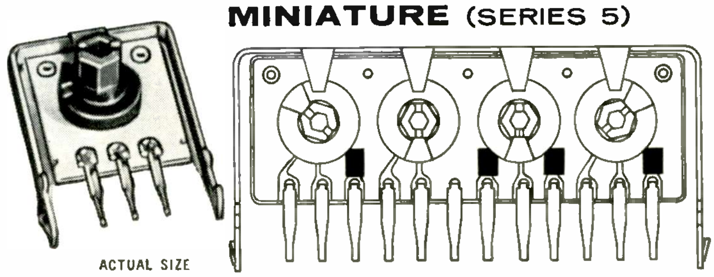
SUB-MINIATURE (SERIES 4)



ACTUAL SIZE

Single trimmer measures only 0.406" x 0.438" x 0.125", rated at 0.1 watts at 70° C. Triple trimmers can include up to 8 fixed resistors, depending on value and voltage rating.

MINIATURE (SERIES 5)



ACTUAL SIZE

Single trimmer measures 51/64" x 45/64" x 19/32". Rated at 1/4 watt at 70° C. Available with leads, solder or wire-wrap terminals, in a wide range of mounting styles for modern production techniques. One to four variable resistor elements and up to 12 fixed resistors on a single plate. Knob permits adjustment by finger tip, internal or external hex wrench, or screwdriver.

For additional information on these units write for CENTRALAB *Engineering Bulletin 42-1216.*

Y-6147

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938L EAST KEEFE AVENUE • MILWAUKEE 1, WISCONSIN
In Canada: Centralab Canada Ltd., P.O. Box 400, Ajax, Ontario

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

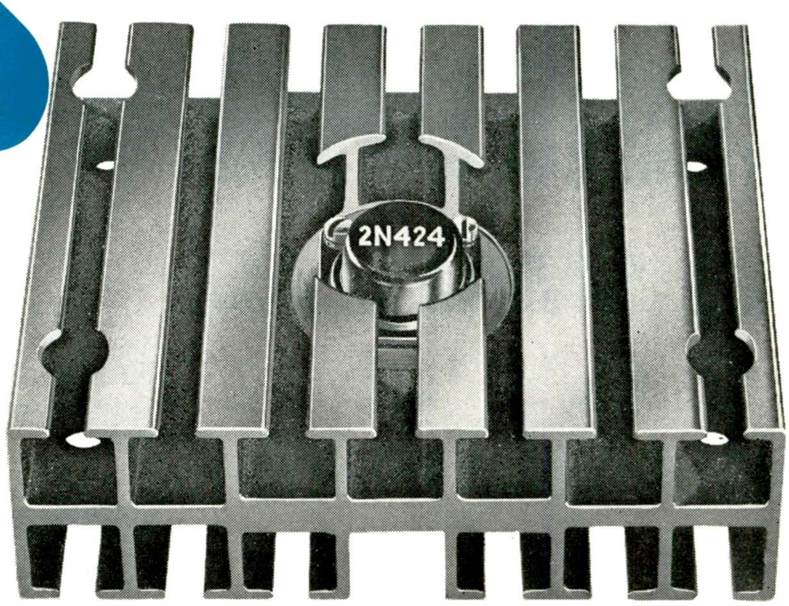
THIS

2N2034

(actual size)

REPLACES

THIS



NEREM Booth 1414

(actual size)

From STC . . . A Significant Technological Breakthrough . . . Miniaturized High Power Silicon Transistors That Don't Require Heat Sinks.

STC's 2N2034 with saturation resistance under 0.3 ohms at 1.0 amps in the TO-5 package improves power switching circuit efficiency by 97% as compared with the 10 ohm 2N424 mounted in a heat sink as illustrated above. Specs: H_{FE} 20 to 60 at 1 amp; BV_{CES} 80 volts min; $I_c = 3$ amps.

(actual size)

The 2N2035 in the TO-8 package and the 2N2036 in the TO-37 package with higher power dissipation are also available.

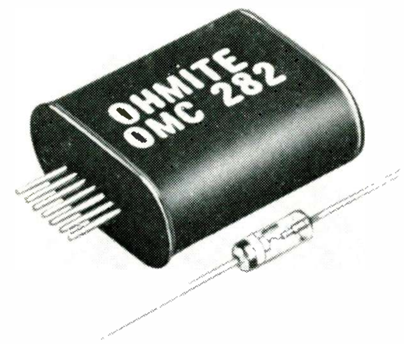
SILICON TRANSISTOR CORPORATION

CARLE PLACE, L. I., NEW YORK, Pioneer 2-4100

New Products

MATCHED DIODE PACKAGE

For use as ring modulator, demodulator or discriminator in SSB equip.

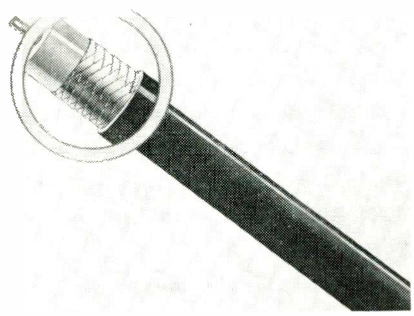


The 4 gold-bonded, hermetically-sealed-in-glass germanium diodes are matched in pairs and then pairs are matched to pairs to obtain a carefully balanced assembly. Matching is maintained over a wide range of voltages and freqs. Diodes are selected so as not to load down input circuits. Temp. range is −65°C to +90°C. The quad is packaged in a subminiature metal case approx. 0.325 x 0.700 x 0.730 in. with a 7 pin in-line single-ended plug termination. Ohmite Mfg. Co., 3640 Howard St., Skokie, Ill.

Circle 292 on Inquiry Card

WOVEN COPPER SHIELD

Shielding technique uses basket woven flat strip copper.



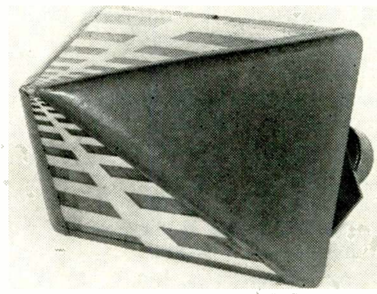
The technique is expected to find wide usage where flexible cables with max. efficiency shields are required to be lightweight and have a min. O.D. Used in a series of coax. cables for community TV systems, the new materials and exclusive techniques have resulted in improved attenuation, radiation characteristics and impedance uniformity. They also reduced weight by 20 to 40% Times Wire & Cable, Div. of The International Silver Co., Wallingford, Conn.

Circle 293 on Inquiry Card

New Products

BROADBAND FEED

Model 761 features a freq range of 600 to 6,000 MC.

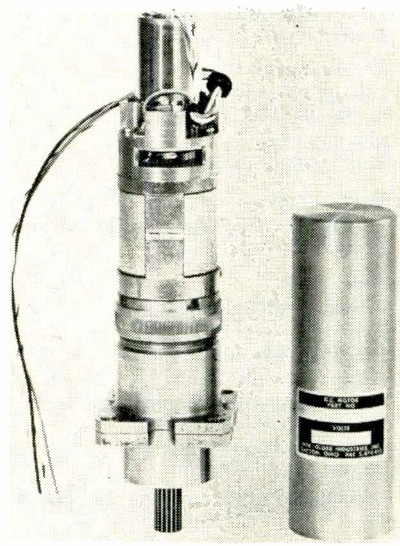


Other specs. include: Polarization—vertical or horizontal, remotely selectable; vswr less than 3:1 relative to 50ω; Impedance, 50ω; Input connector—Type N; and Patterns—provides −10 db edge illumination on a parabolic reflector with f/d of 0.4. Granger Associates, 974 Commercial St., Palo Alto, Calif.

Circle 294 on Inquiry Card

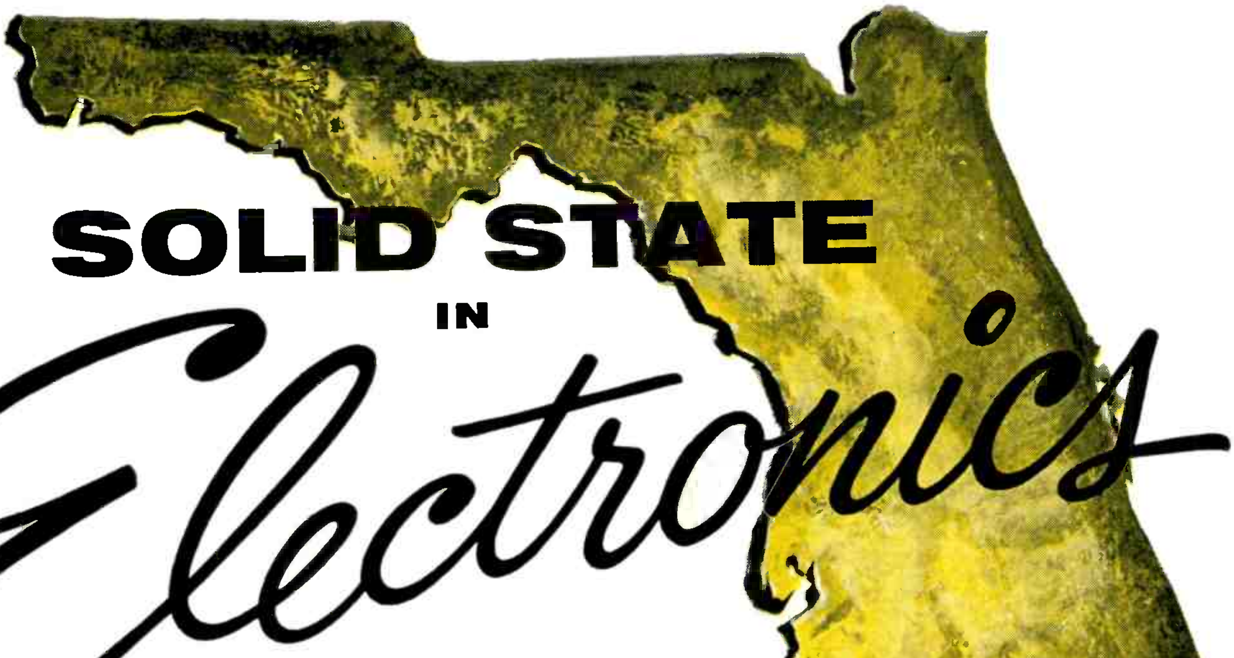
DC SERVO MOTOR

Permanent magnet unit has planetary gear reducer and dc rate tachometer.



The unit can be used in a transistorized servo system and is capable of producing torques in excess of 100 in. lbs. through a speed range of at least 1 RPM to 15 RPM. Feedback is 8 vdc/1000 RPM. The gear reducer has all bearings of the anti-friction type. The rate tachometer provides feedback information to permit control wide speed ranges. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

Circle 295 on Inquiry Card



SOLID STATE IN *Electronics*

Men of vision thrive here. And it takes men of vision to cope with today's electronics and space problems. Space in more ways than just up. Space problems of a different nature plague the manufacturer who must expand, but hasn't the land to expand on.

Here in Florida we have the space, the climate, the work force. Florida has more to offer electronics firms than any other area on earth. Men think better where life is pleasant, where off hours can be devoted to just plain *living*—and to just plain *thinking*.

Yes, Florida is a Solid State in Electronics. Already the sun, Mother of Life, shines on over sixty thriving electronics firms in our busy state.

Cape Canaveral is here, too, with its massive, awesome missiles blasting off to make space history. Electronics makes possible every thrust into the universe. Every hope of getting to the moon depends upon electronics—and the first American to the moon will definitely soar to history from Florida.

Engineers and their families dream of living here in Florida. Give them this dream by moving your plant here. Nurture the brains that will give your business a greater and greater stature in this, the Electronics Age.

For complete details of the many advantages Florida offers the Electronics Industry, write us. Let us tell you why some of the greatest names in electronics have impressive plants here in Florida.

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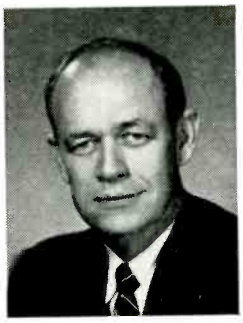
Governor, State of Florida



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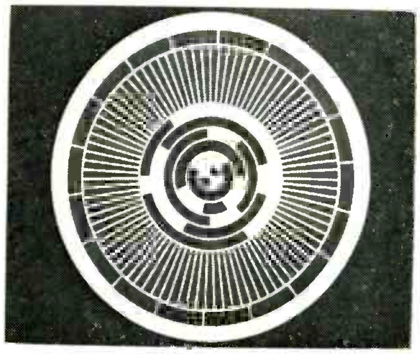
GLASS-BONDED MICA

Metal clad Mykroy[R] is arc-proof and radiation resistant.

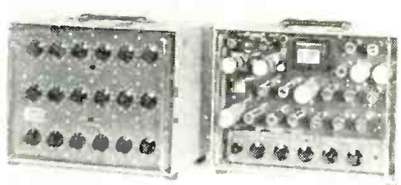


Chief among its properties is infinite dimensional stability, for use in memory systems, switching devices, printed circuits, and micromodular packages. Mykroy glass-bonded mica will not bend, warp, or change its size or shape under extremes of temp. and humidity. Available in sheets and rods, and as custom-made insulators with finished circuitry. Also available is a designer's sample kit containing metal-clad Mykroy, etchants, resists, and instructions. Molecular Dielectric, Inc., Clifton, N. J.

Circle 295 on Inquiry Card

TIME DOMAIN EQUALIZER

Corrects waveform defects in TV, radar pulse or wideband signals.



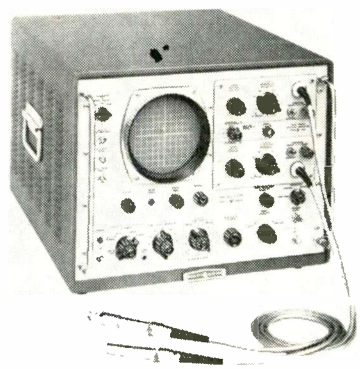
A TV signal may be either color or monochrome, composite or non-composite. The repetition rate of the other waveforms also does not matter. The defects may be in any region of the video or wideband spectrum. A very important function of this equipment is its ability to easily correct high freq. distortions such as overshoots, ringing, smears, etc. In addition to the high freq. correction facilities, circuits are provided for mid-freq. (100-500 KC) as well as low freq. (60 CPS) corrections. Telechrome Mfg. Corp., 28 Ranick Dr., Amityville, N. Y.

Circle 297 on Inquiry Card

New Products

SAMPLING OSCILLOSCOPE

Gives calibrated, high resolution measurement of nsec. pulse phenomena.

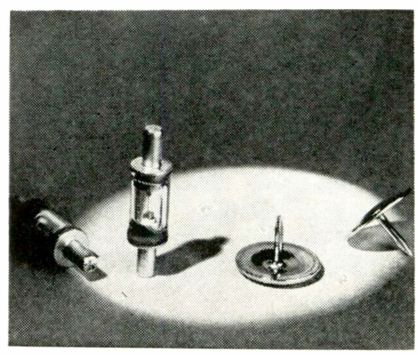


Model 185B features conventional controls, direct reading and bright-trace observation, and a standard 5 in. mono-accelerator CRT. When equipped with a Model 187B plug-in dual trace amplifier, the oscilloscope has a pass band from dc to 1000 MC, can be synchronized up to 1000 MC, and permits full screen presentation of signals from 0.3 nsec. to 100 nsec. Hewlett Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.

Circle 290 on Inquiry Card

VARACTOR DIODES

For operation as harmonic generators up to 10 GC.



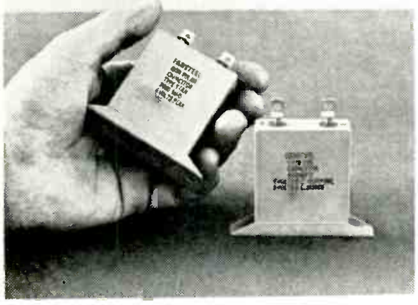
Types L-4110, L-4111, and L-4112, have the following characteristics: Max. power dissipation—0.5w., 0.3w., 0.1w.; Breakdown voltage (at $-200\mu a$) —80 v., 40 v., 20 v.; Junction capacitance (at 100 KC and varactor biased at ⅓ V_b)—1.0—2.0 pf, 0.35—0.7 pf, 0.17—0.35 pf; Series resistance (typical; measured at 2 GC and varactor biased at ⅓ V_b)—5ω, 6ω, 7ω; Cutoff freq. (calculated at 1.3 V_b)—25 GC, 60 GC, 100 GC; Lead inductance (typical; measured at 2 GC) —0.4 nh; Cartridge capacitance (typical measured at 100 KC)—0.2 pf. Philco Corp., Lansdale Div., Lansdale, Pa.

Circle 291 on Inquiry Card

New Products

TANTALUM CAPACITORS

Polar series from 0.3 to 4 nf; non-polar series from 0.15 to 2.0 nf.

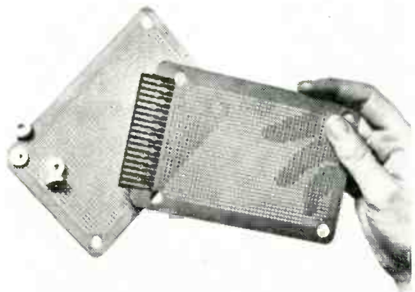


The new solid tantalum lines have 10 Type STA in the polar series and 10 Type STAN in the non-polar series. All ratings are for 6 to 35 wvdc max. at amb. of −55°C to +125°C, with linear voltage de-rating above 85°C values to 67% at +125°C. Standard production tolerances are ±20% of nominal capacitance at 25°C and 120 CPS. They are housed in insulated, hermetically sealed cases. Rectifier - Capacitor Div., Fansteel Metallurgical Corp., N. Chicago, Ill.

Circle 287 on Inquiry Card

GRID BOARDS

Two new configurations in Fotoceram printed circuit grid boards.

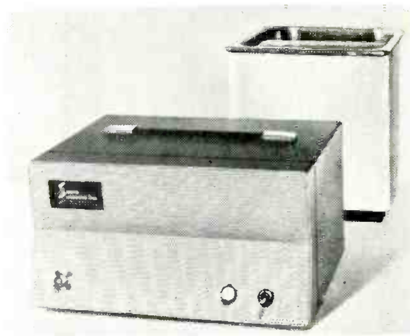


One has new corner mounting holes; the other has the mounting holes plus a plug section useful for computer design work. The grid boards consists of copper-clad Fotoceram glass-ceramic with a grid of 0.052 in. through-plated holes set 0.1 in. on center. The new boards, equipped with silicone rubber mounting grommets, are available in 4 x 6 and 6 x 8 in. sizes. Corning Glass Works, Bradford, Pa.

Circle 288 on Inquiry Card

ULTRASONIC CLEANER

Combines self tuning, high reliability, and ruggedness with low cost.



Model MS90 requires no operator attention. The generator has a power capability of 90 (av) w., 360 w. peak. It contains a single tube in a half-wave self rectifying circuit. Generator works on a scanning principle for more efficient over-all cleaning. Input 117 vac, 60 CPS. Dimensions: 11 x 10 x 6½ in. Transducer MST 901 has full inside tank dimensions of 7¼ x 9¼ x 4 in. deep. Sonic Systems, Inc., 1250 Shames Dr., Westbury, N. Y.

Circle 289 on Inquiry Card

Circle 108 on Inquiry Card

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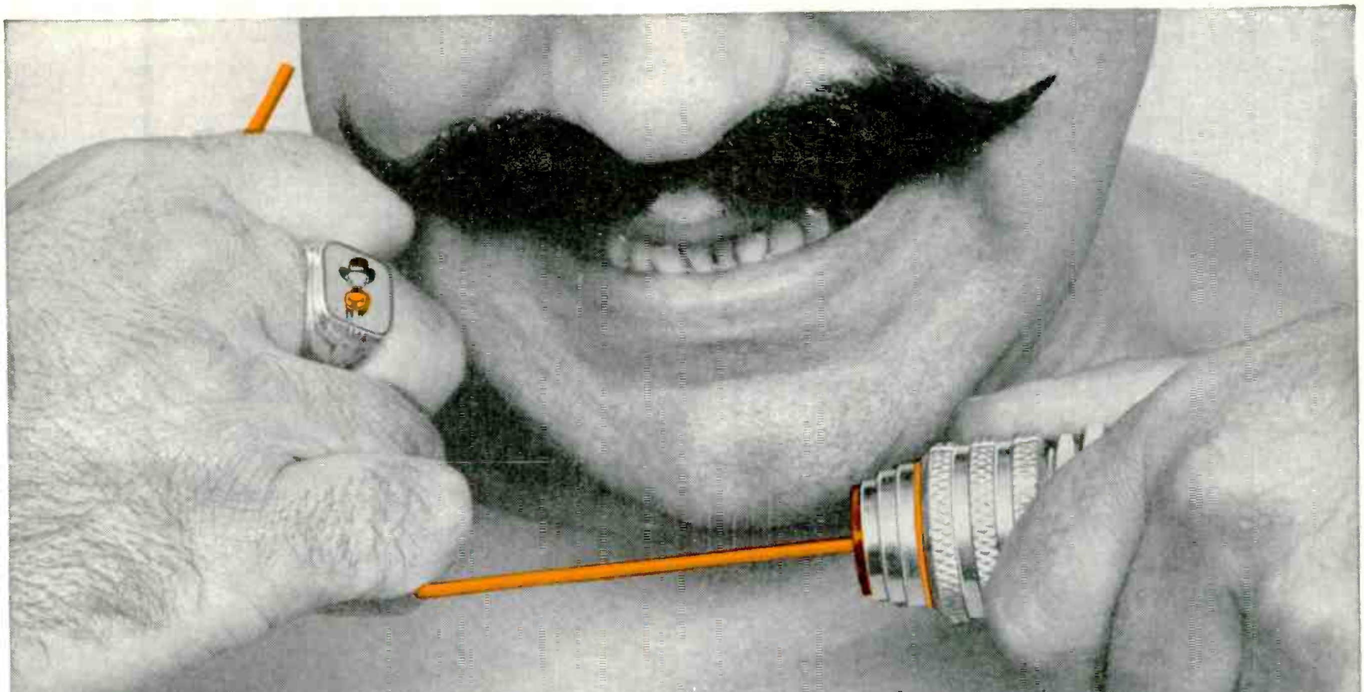


Snaps in – Stays in

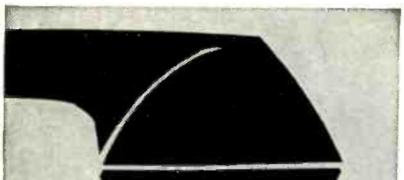
There's muscle in that Deutsch snap-in contact...enough to withstand 25 pounds pull. Each pin and socket in the DS miniature electrical connector is locked in place by a patented spring mechanism that can only be released by specially designed tools. Add to this a crimp that is strong as AN #18 wire itself, and you have the completely reliable DS snap-in type connector. What's more... crimping, inserting, and removing contacts is a quick and easy operation with Deutsch designed tools...even in the hands of unskilled operators. The DS series also features the Deutsch ball-lock coupling mechanism which operates in the direction of plug travel...just push to connect and pull to disconnect. With environmental performance that meets or exceeds MIL-C-26482, plus a wide range of shell sizes and contact arrangements, this connector will satisfy your toughest design requirements with ease.*

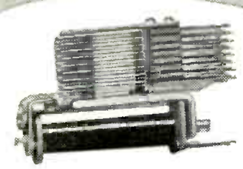
DEUTSCH

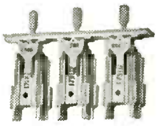
Electronic Components Division • Municipal Airport • Banning, California

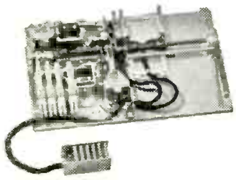
ADVANCED SPECIFICATION MINIATURE ELECTRICAL CONNECTORS

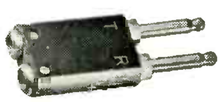
*For complete information contact your Deutschman or write for Data File A-11.











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CODI

EPOXY ENCAPSULATED SILICON RECTIFIERS

New Small Size / Double Sealed
All Welded Construction
Low Leakage / High Current
Polarized for Automatic Insertion

Specifications for CODI Rectifier Types CODI 531 to 538

Electrical Characteristics	CODI 531	CODI 532	CODI 533	CODI 534	CODI 535	CODI 536	CODI 537	CODI 538	UNITS
Max. forward voltage drop @ 500 mA	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	volts
Max. reverse leakage @ rated voltage	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	μA
Max. reverse leakage under load (Note 1)	50	50	50	50	50	50	50	50	μA
Max. forward voltage drop under load (Note 1)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	volts
Maximum Ratings									
Peak Inverse Voltage	100	200	300	400	500	600	700	800	volts
Applied R M S Voltage	70	140	210	280	350	420	490	560	volts
Surge Current for one cycle	35	35	35	35	35	35	35	35	Amps
Average rectified current @ 25°C	750	750	750	750	750	750	750	750	mA
Average rectified current @ 100°C	500	500	500	500	500	500	500	500	mA

Operating and Storage Temperature Range —65°C to +150°C
All specifications at 25°C unless otherwise stated.

Note 1: Average over one cycle for full wave choke or resistive circuit with rectifier operating at rated current.

Computer Diode manufactures

- General Purpose Diodes
- 250 mW Zener Diodes
- 400 mW Zener Diodes
- Special Circuit Packages
- Non-Metallic Epoxy Rectifiers

COMPUTER DIODE CORPORATION

250 GARIBALDI AVENUE • LODI, NEW JERSEY • PRESCOTT 3-2511

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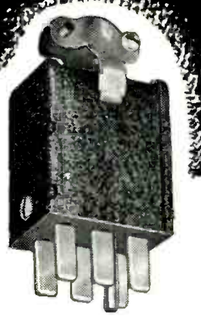
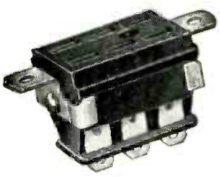
FOR PUBLIC ADDRESS, RADIO, and kindred fields, specify JONES 400 SERIES PLUGS AND SOCKETS of proven quality!



P 406-CCT



S 406-AB

Double Contact Area

Phosphor bronze knife-switch socket contacts engage both sides of flat plug contacts.

Socket contacts phosphor bronze, cadmium plated. Plug contacts hard brass, cadmium plated. Insulation molded bakelite. Plugs and sockets polarized. Steel caps with baked crackle enamel 2, 4, 6, 8, 10, 12 contacts. Cap or panel mounting.

Information on complete line, in Jones Catalog 22, Electrical Connecting Devices, Plugs, Sockets, Terminal Strips. Write

HOWARD B. JONES DIVISION
CINCH MANUFACTURING COMPANY
CHICAGO 24, ILLINOIS
DIVISION OF UNITED-CARR FASTENER CORP.

Jones

Circle 122 on Inquiry Card

Do you know?

...a new 20-page catalog of the complete Hi-Q line of precision wire-wound resistors has just been printed. Includes performance characteristics and MIL Spec info on encapsulated units with axial and radial wire terminals, turret lug and radial lug terminals, and Hi-Q micro-miniature series. For your FREE copy write on your letterhead today to...

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Division

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NOW...2 YEAR WARRANTY ON ALL HI-Q CAPACITORS & RESISTORS

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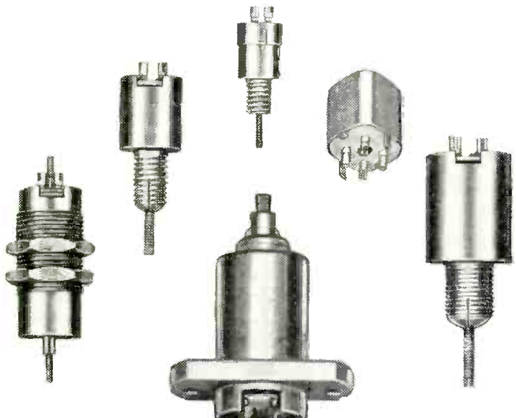

We wind to your specs

CAMBION® has all the facilities and forms — standard, printed circuit and shielded — required to wind coils to your exact specifications . . . with quick deliveries in any quantities you order . . . and *quality-guaranteed* like all CAMBION components. Whatever qualification testing you might require is also available in CAMBION's fully equipped environmental laboratories, for thorough checking of your coils before shipment. Technical service is as prompt as deliveries, too. Have a CAMBION Sales Engineer call to discuss your requirements for custom wound coils, or mail your blueprints to Cambridge Thermionic Corporation, 504 Concord Ave., Cambridge 38, Massachusetts.

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CAMBION®
The guaranteed electronic components

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NEW solder discovery!

Two outgassed solders. Left, standard solder. (Note degree of oxides present.) Right, ALPHA *Vaculoy* solder is bright, clean, oxide free!

ALPHA *Vaculoy*® bar solder cuts printed circuit joint rejects from 1-in-50 to 1-in-5,000. No other solder does this because no other is *made* this way!

Above is an unretouched photograph of two solder specimens—both outgassed. Left, is a *standard* printed circuit solder. Note presence of impurities on surface—a sure sign of undesirable oxides. Right, is ALPHA *Vaculoy*.* Its bright, clear surface indicates freedom from oxide-forming elements. Result? ALPHA *Vaculoy* bar solder cuts dross, improves wetting, produces brighter connections, increases bath life, reduces inherent inclusions and insures reliable electrical connections. Meets Fed. Specs. QQS-571C. Get all the facts. *Write for data today!*

*Formerly called "ALPHA AAA"

When dependability counts!

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In Los Angeles, Calif.: 2343 Saybrook Ave.
In Chicago, Ill.: ALPHALOY Corp., 2250 S. Lumber St.
Other ALPHA products: Fluxes • Solder Preforms • High Purity Metals

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Scatter 7
Transmitters 8

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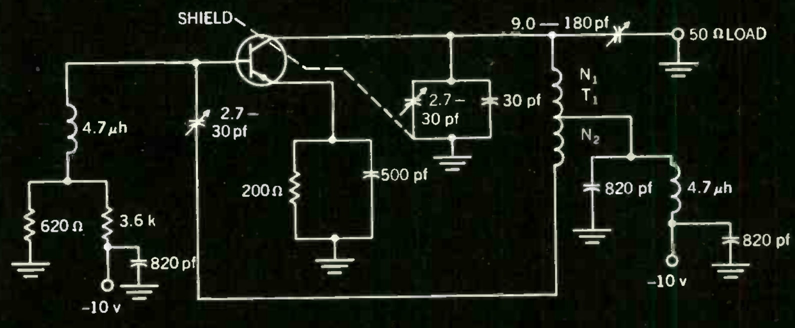
DALMESA APPLICATION REPORT NUMBER 1

30 MC OSCILLATOR

CIRCUIT PERFORMANCE CHARACTERISTICS

OSCILLATOR EFFICIENCY	24.7% @ −40°C 22.2% @ +70°C
RF POWER OUT	23.1mw @ −40°C 20.4mw @ +70°C



T_1 #516 AIR DUX OR EQUIVALENT N_1 4 TURNS; N_2 7 TURNS; ALL RESISTOR VALUES ½w 10%

New TI DALMESA Transistors Give IMPROVED HF Oscillator Performance From −40 to +70°C

■ **Solve your industrial communications design problems today** with TI's new DALMESA 2N2188 series. This new germanium alloy diffused mesa transistor family is specifically designed to meet your requirements for high-performance, low-noise, economically-priced transistors for application over the entire communications band from dc to 150 mc. ■ The **extremely low, low-frequency noise corner** and **high alpha cutoff frequency** offered by new DALMESA transistors result in **low-noise performance over a very wide bandwidth** —the 2N2188 series gives you a typical mid-frequency noise figure of 1.5 db.

■ These new devices also give you **guaranteed gain/bandwidth products of 60 and 102 mc** to assure excellent performance in your IF, RF and video amplifiers. **Increased high-frequency stability** results from the guaranteed **maximum output capacitance of 2.5 pf at 9 volts.** ■ Apply new **DALMESA** transistors to your communications designs today and take advantage of the increased performance capabilities of this new Texas Instruments series. These new 125-mw transistors are **immediately available** through your nearest TI Sales Office or Authorized TI Distributor.

PARAMETER	TEST CONDITIONS	2N2188	2N2189	2N2190	2N2191
BV_{CBO}† AND BV_{CES}	$I_C = -50\ \mu a$	40 v min	40 v min	60 v min	60 v min
BV_{EBO}	$I_C = 0,\ I_E = -100\ \mu a$	2 v min	2 v min	2 v min	2 v min
h_{FE}	$V_{CE} = -6\ v\ I_C = -2\ ma$	40 min	60 min	40 min	60 min
h_{fe} (at 1 kc)	$V_{CE} = -6\ v,\ I_E = -2\ ma$	40 min	60 min	40 min	60 min
f_T	$V_{CE} = -9\ v,\ I_E = -1.5\ ma$	60 mc min	102 mc min	60 mc min	102 mc min
I_{CBO}	$V_{CB} = -12\ v,\ I_E = 0$	3 μa max	3 μa max	3 μa max	3 μa max
C_{OB} (at 1 mc)	$V_{CB} = -9\ v,\ I_E = 1.5ma$	2.5 pf max	2.5 pf max	2.5 pf max	2.5 pf max
Noise Figures§ (at 1 mc)	$V_{CE} = -5\ v,\ I_E = 0.5\ ma$	1.5 db typ	1.5 db typ	1.5 db typ	1.5 db typ
Maximum Power Dissipation	25°C Ambient	125 mw	125 mw	125 mw	125 mw

† $I_E = 0$ § $R_G = 1K\Omega$

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TRANSISTOR PRODUCTS DIVISION

TEXAS INSTRUMENTS INCORPORATED
13500 N. CENTRAL EXPRESSWAY
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18612

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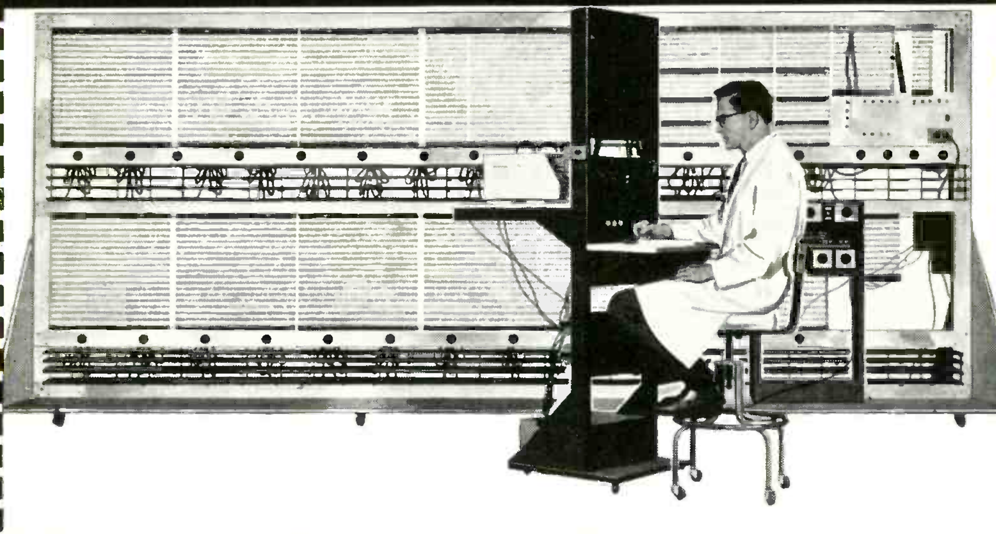
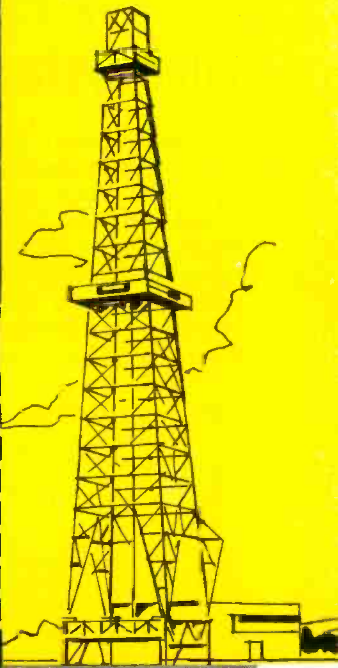
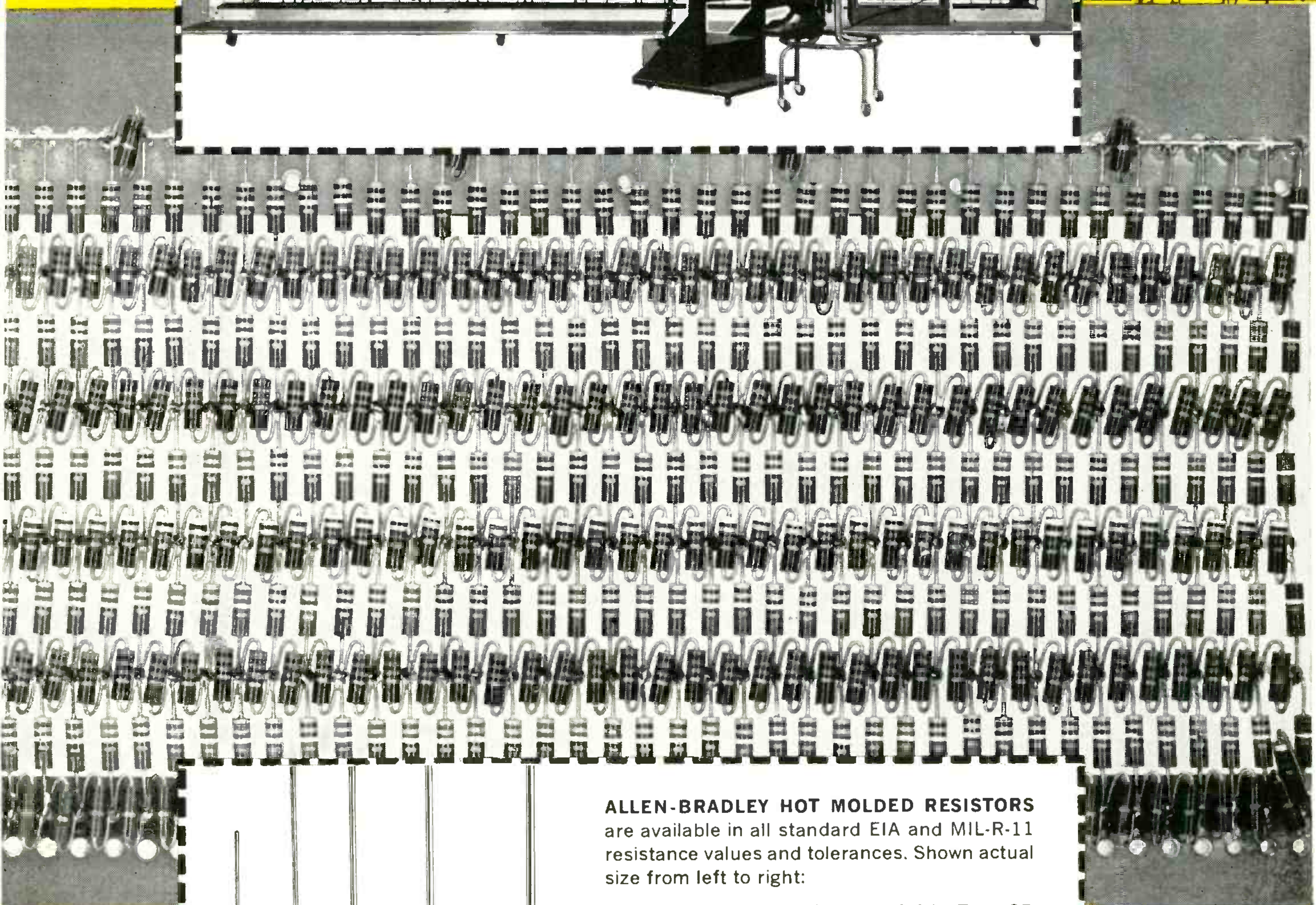
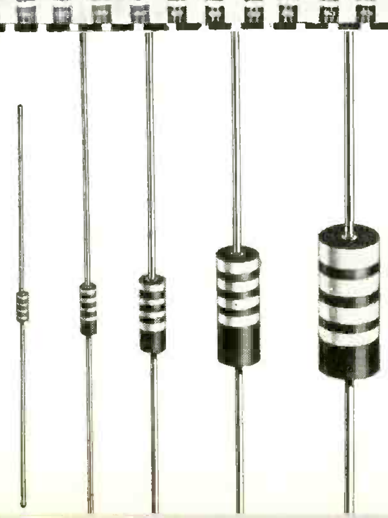
This complex resistor network at Schlumberger's Research Center contains in its basic assembly some 150,000 of the 500,000 Allen-Bradley hot molded resistors which they have assembled into grids simulating earth formations. By inserting interchangeable grids into the network in various combinations, it is possible to simulate the borehole and formation parameters which affect resistivity measurements. Duplication of formation characteristics permits a more precise examination and interpretation of the different resistivity logs used in locating potential gas and oil producing zones.









ALLEN-BRADLEY HOT MOLDED RESISTORS are available in all standard EIA and MIL-R-11 resistance values and tolerances. Shown actual size from left to right:

Type TR 1/10 watt (MIL Type RC 06), Type CB 1/4 watt (MIL Type RC 07), Type EB 1/2 watt (MIL Type RC 20), Type GB 1 watt (MIL Type RC 32), Type HB 2 watts (MIL Type RC 42).

A-B also makes a quality line of hermetically sealed precision resistors. Using metal grid construction, they are noninductive. Ratings are 1/4, 1/2 and 1 watt at 125° C with tolerances of 0.1, 0.25, 0.5 and 1.0%; and TC ±25 PPM.

Industry News

Wilson P. Green—appointed Manager of Manufacturing Equipment for Cinch Mfg. Co., Chicago, Ill.

John G. Norris—appointed Assistant to the President, Fansteel Metallurgical Corp., North Chicago, Ill.

Daniel Schwarzkopf—named General Manager, Unimax Switch Div., Maxson Electronics Corp., Wallingford, Conn.

Donald A. Davis—appointed Assistant to President, Avnet Electronics Corp., Westbury, L. I.

I. Nevin Palley—elected Executive Vice President, Curtiss-Wright Corp., Wood-Ridge, N. J.

I. N. Palley

R. L. Jandl

Richard L. Jandl — named Vice President and General Sales Manager, Sola Electric Co., division of Basic Products Corp., Elk Grove Village, Ill.

Raymond A. Wasson—named Manager, Radome Dept., Corning Glass Works, Corning, N. Y.

Transitron Electronic Corp., Wakefield, Mass. announces the following appointments: **George C. Messenger**—named Operations Manager, Transistors; **Windsor H. Hunter**—named Operations Manager - Diodes; **Vladimir N. Chernyshov** — named Operations Manager-Rectifiers; and **Roderic E. Hall**—named Operations Manager-Special Products.

Roy L. Ash — elected President, Litton Industries, Inc., Beverly Hills, Calif.

General Electric Co., New York, N. Y., announces the following appointments: **Charles J. Ellis**—elected Southeastern Regional Vice President and **Harry P. Gough**—elected Western Regional Vice President.

Rotron Mfg. Co., Inc., Woodstock, N. Y., announces the following appointments: **David Carlson** — appointed Manager, Special Products Section, **Percy L. Lyon, Jr.** — appointed Manager, Application Engineering; and **Robert Raible**—assigned as RMO Specialist.

(*Continued on P. 201*)

Industry News

Edward J. Whalen—elected Vice President and Deputy Chief Executive Office, ITT Communications Systems, Inc., subsidiary of International Telephone and Telegraph Corp., Paramus, N. J.

Dr. Bernard Wambsganss—named Assistant to President, Alfred Electronics Corp., Palo Alto, Calif.

Jerrold Electronics Corp., Phila., Pa., announces the following appointments: **Robert H. Beisswenger**—named General Manager, Jerrold-Philadelphia; and **Donald Spanier**—named General Manager, Harman-Kardon.

J. R. (Bob) Stone—named General Sales Manager, C. P. Clare & Co., Chicago, Ill.

J. R. Stone

M. W. Kremer

Merle W. Kremer—appointed Vice President, Electronic Tube Div., Sylvania Products Inc., New York, N. Y.

Bruce Burnett—named Marketing Manager, Ark Electronics Corp., Willow Grove, Pa.

Edward A. Galiskis—elected President, Pitometer Log Corp., N. Y.

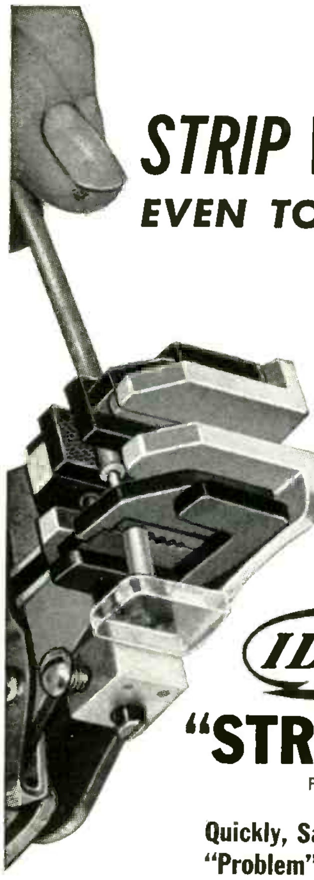
Freeman F. Desmond—appointed Eastern Region Sales Manager, Times Wire and Cable Co., Inc., Wallingford, Conn.

David E. McElroy—named Manager, Chemical Material & Process Engineering Dept., International Resistance Co., Phila., Pa.

Harold W. Kaye—named Technical Assistant to the Vice President and General Manager, Adler Electronics, Inc., New Rochelle, N. Y.

General Instrument Corp., Semiconductor Div., Newark, N. J., announces the following appointments: **Ronald Friedman**—named Distributor Field Sales Manager and **William Carlson**—appointed Headquarters Distributor Sales Manager.

Charles "Chuck" Sutton—appointed National Sales Manager, Chicago Telephone of California, Inc., South Pasadena, Calif.



STRIP WIRE FAST--
EVEN TOUGH TEFLON*

WITHOUT A NICK!

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Quickly, Safely Removes "Problem" Insulation from Wire

Now strip the toughest insulation from any wire with just a gentle, harmless squeeze. With Ideal Custom Stripmaster, matched sets of counterbored blades—*precision drilled on watchmaker's equipment to fit wire sizes exactly* are designed to ride on cut insulation, and eliminate wire nicking and scraping. Firm grip of jaws prevents insulation damage. Wire is stripped absolutely clean up to a full 7/8".

Optional transparent wire stop quickly adjusts so that you strip off the exact amount of insulation you want every time. Perfect for fast, accurate production line stripping.

Custom Stripmasters come in three models for 10 to 14, 16 to 26, or 26 to 30 wire gauges.

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The Custom Stripmaster is just one of a complete line of Ideal strippers including Thermo-Strip and high-speed electrically powered models for every insulation-removal need. WRITE FOR NEW WIRE STRIPPER BROCHURE.

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IDEAL

Please send me a copy of your new WIRE STRIPPER BROCHURE

Name ____________________

Company ____________________

Address ____________________

City __________ Zone ______ State __________

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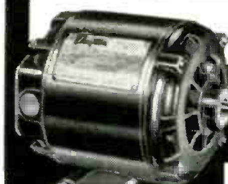
SPECIALISTS IN ELECTRIC
MOTORS
1/100 to 60 HP



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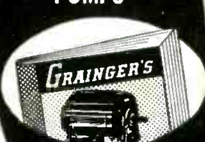

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ANTENNAS, PROPAGATION

The Behavior of Short Linear Aerials on Varying the Distribution of Current, G. D'Auria and F. Todero. "Alta Freq." July 1961. 15 pp. The behavior of short linear aerials is studied by varying the distribution of current by means of loads on top of the aerials. (Italy, in English.)

An Installation to Investigate Directional Properties of an Antenna. V. D. Kuznetzov, V. K. Paramonoff. "Radiotek" 16, No. 8, 1961. 8 pp. A simple installation is described, which can be used to investigate operationally directional diagrams of an antenna, observing them on a cathode ray tube screen, a recording screen or a photographic screen. (U.S.S.R.)

The Operation of Cage Antennas for VOR-Stations, H. Brunswig. "Nach. Z." August 1961. 8 pp. The operation of cage antennas is explained. The cage is treated as a system of linked parallel wire lines which are interconnected by a plate thus forming the radiator. (Germany.)

COMMUNICATIONS

Accumulation of Noise and Fading in Single Band Radio Communication Relay Lines. V. I. Siforov, A. V. Prossin. "Radiotek" 16, No. 8, 1961. 3 pp. A method is given to calculate noise and fading accumulation in multi-channel radio—relay communication lines with single band modulation. (U.S.S.R.)

Applications of the Method of Signal Extrapolation Used in Pulse Noise Suppression. A. A. Gorbatcheff, M. I. Vinogradoff, "Radiotek" 16, No. 8, 1961. 6 pp. A method to realize signal extrapolation using a stepped polynominal is given and experimental results from using it to suppress pulse noise is presented. (U.S.S.R.)

Limiter and Discriminator in FM Receiver, E. Paulsen. "El. Rund." Aug. 1961. 2 pp. Described is the effect of limiter and discriminator properties upon the signal/noise ratio required in the reception of two FM transmitter programs. (Germany.)

FM Reception Under Conditions of Strong Interference, J. van Slooten. "Phil. Tech." #11, 1961. 9 pp. Effects observed in the reception of frequency-modulated signals under conditions of strong interference are capable of exact analysis. However, the mathematical difficulties involved, although not insurmountable, make the theory difficult to grasp. The problem is approached with the aid of simple expressions which, though not new, are seldom employed. The result is a relatively simple formula which satisfactorily describes the effects concerned. (Netherlands in English.)

Certain Relationships in a Frequency Detector Circuit Containing Two Consecutively Switched Constant Current Diodes. Y. L. Mazor. "Radiotek" 16, No. 8, 1961. 4 pp. Cut-off angles are determined for a detector system with two consecutively switched diodes. The cut-off angles depend on the impressed high frequency voltages and a number of other parameters. The operation of this circuit is analyzed for both a short time constant load and a long time constant load. (U.S.S.R.)

Symbolic Logic for Computer Circuit Application, B. R. Willins. "El. Tech." Sept. 1961. 8 pp. The elements of Boolean algebra and Venn diagrams are explained, and their applications considered first to verbal statements and then to the description of some switching and computer circuits. Finally, the methods are used in a simple design problem of a type which could be met in a digital computer. (England.)

CONTROLS

Optimum Control in Second-Order Pulse-Relay System with Random Disturbances, V. N. Novoseltsev. "Avto. i Tel." July 1961. 11 pp. Optimum control in second-order pulse-relay (digital) systems is considered. (U.S.S.R.)

Automatic Optimization by Statistical Criteria, S. A. Doganovsky. "Avto. i Tel." July 1961. 12 pp. Statistical criteria are defined and the performance of control systems with automatic optimization by statistical criteris is investigated. (U.S.S.R.)

The Design of Voltage Controlling Transductors which Act as Regulating Units in Control Systems, H. Winkler. "rt." July 1961. 5 pp. From the load characteristics relationships are determined and these are used for defining the complete voltage control range which is the basis for the design of the transductors. (Germany.)

Three-phase Transductors for the Supplementary Voltage Regulation of Compounded Synchronous Generators, Werner Droste and Heinz Janzen. "AEG Prog." #7, 1961. 4 pp. A simple form of 3-phase transductor as correcting unit for the supplementary automatic control system of compounded synchronous generators of high rating is described. (Germany in English)

Video Cross-Connection Distributor. "Rundfunk." April 1961. 5 pp. The paper describes a remotely-controlled distribution installation constructed on the principle of the filter cross-connector and which incorporates transistorized video amplifiers. (Germany)

Requirements to Contactless Control and Designing for Industrial Application, E. Rohloff. "El Rund." March 1961. 4 pp. Contactless control devices are increasingly introduced in the industry because of advantages compared with contactors. Requirements to such devices are compiled, and the author shows how they can be met with transistor units. (Germany)

Control Systems with Standard Equipment, H. Sartorius, "Rt." Feb. 1961. 6 pp. The histroical development of standard control equipment is shown, taking, as an example, pneumatic control systems as utilized in the petroleum industry. (Germany)

(Continued on page 211)

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AUSTRALIA

AWA Tech. Rev. AWA Technical Review
Proc. AIRE. Proceedings of the Institution of Radio Engineers

CANADA

Can. Elec. Eng. Canadian Electronics Engineering
El. & Comm. Electronics and Communications

ENGLAND

ATE J. ATE Journal
BBC Mono. BBC Engineering Monographs
Brit. C.&E. British Communications & Electronics
El. Tech. Electronic Technology
GEC J. General Electrical Co. Journal
J. BIRE. Journal of the British Institution of Radio Engineers
Proc. BIEE. Proceedings of Institution of Electrical Engineers
Tech. Comm. Technical Communications

FRANCE

Bull. Fr. El Bulletin de la Societe Francaise des Electriciens
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Comp. Rend. Comptes Rendus Hebdomadaires des Seances
Onde. L'Onde Electrique
El. et Auto. Electronique et Automatisme
Rev. Tech. Revue Technique
Telonde. Telonde
Toute R. Toute la Radio
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GERMANY

AEG Prog. AEG Progress
Arc. El Uber. Archiv der Elektrischen Ubertragung
El Rund. Electronische Rundschau
Freq. Frequenz
Hochfreq. Hochfrequenz-technik und Electroakustik
Nach. Z. Nachrichtentechnische Zeitschrift
Rt. Regelungstechnik
Rundfunk. Rundfunktechnische Mitteilungen
Vak. Tech. Vakuum-Technik

POLAND

Prace ITR. Prace Instytutu Tele-I Radiotechnicznego
Roz. Elek. Rozprawy Electrotechnizne

USSR

Avto. i Tel. Avtomatika i Telemakhanika
Radio. Radio
Radiotek. Radioteknika i Elektranika
Rad. i Elek. Radioteknika i Elektranika
Iz. Acad. Bulletin of Academy of Sciences USSR.

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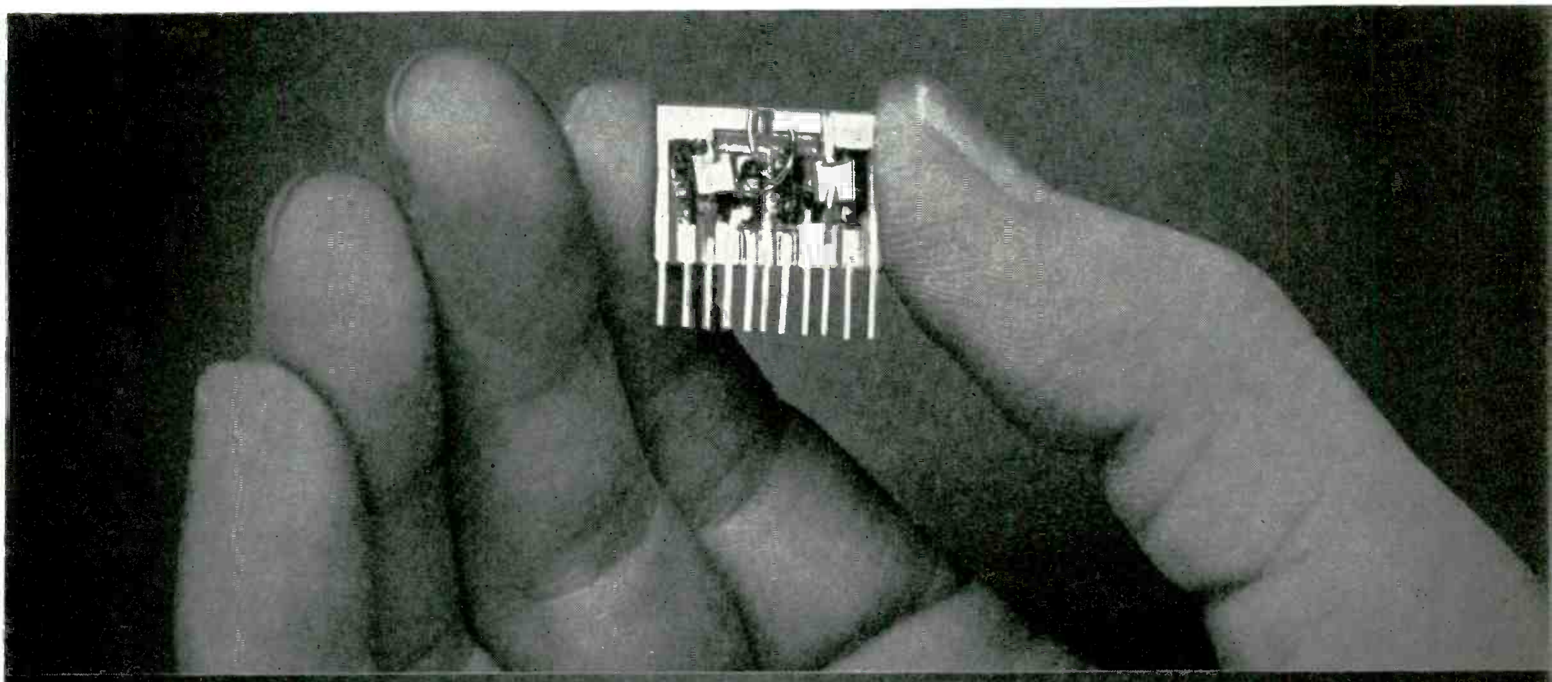

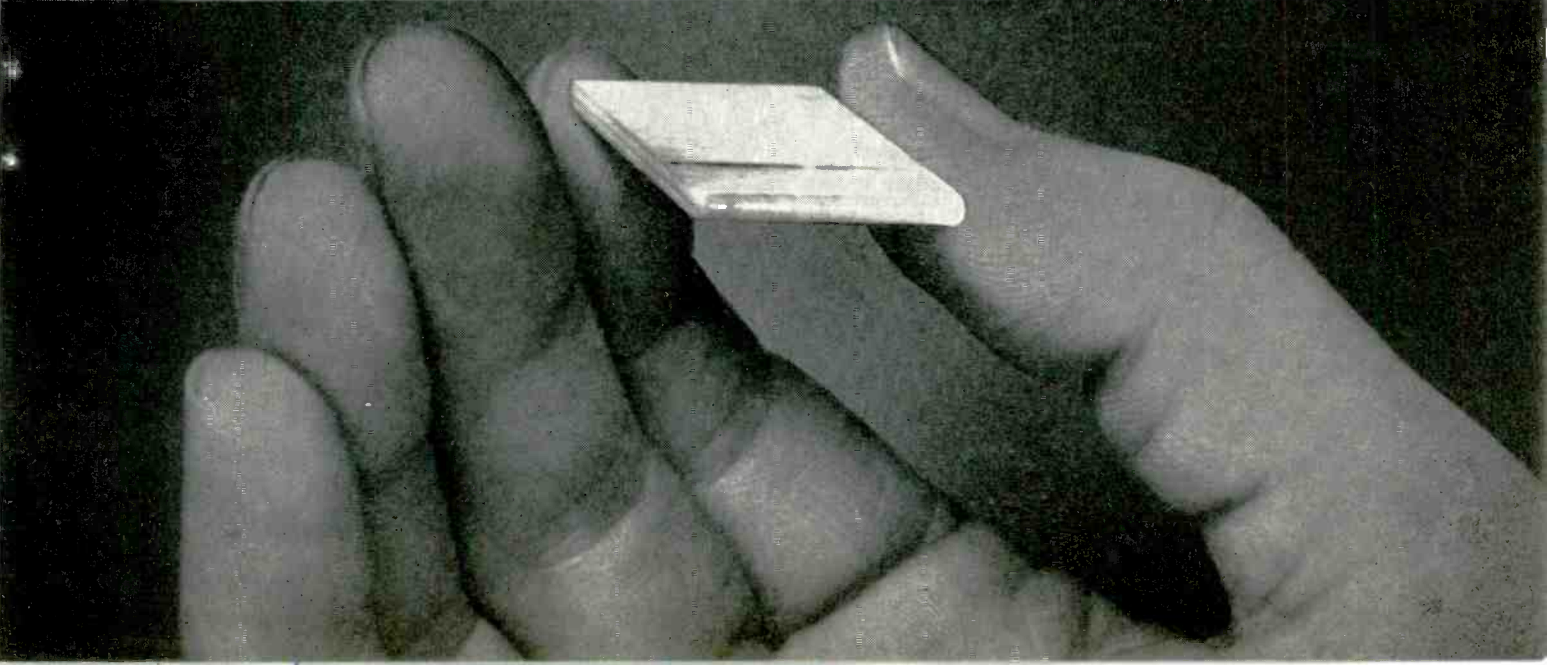

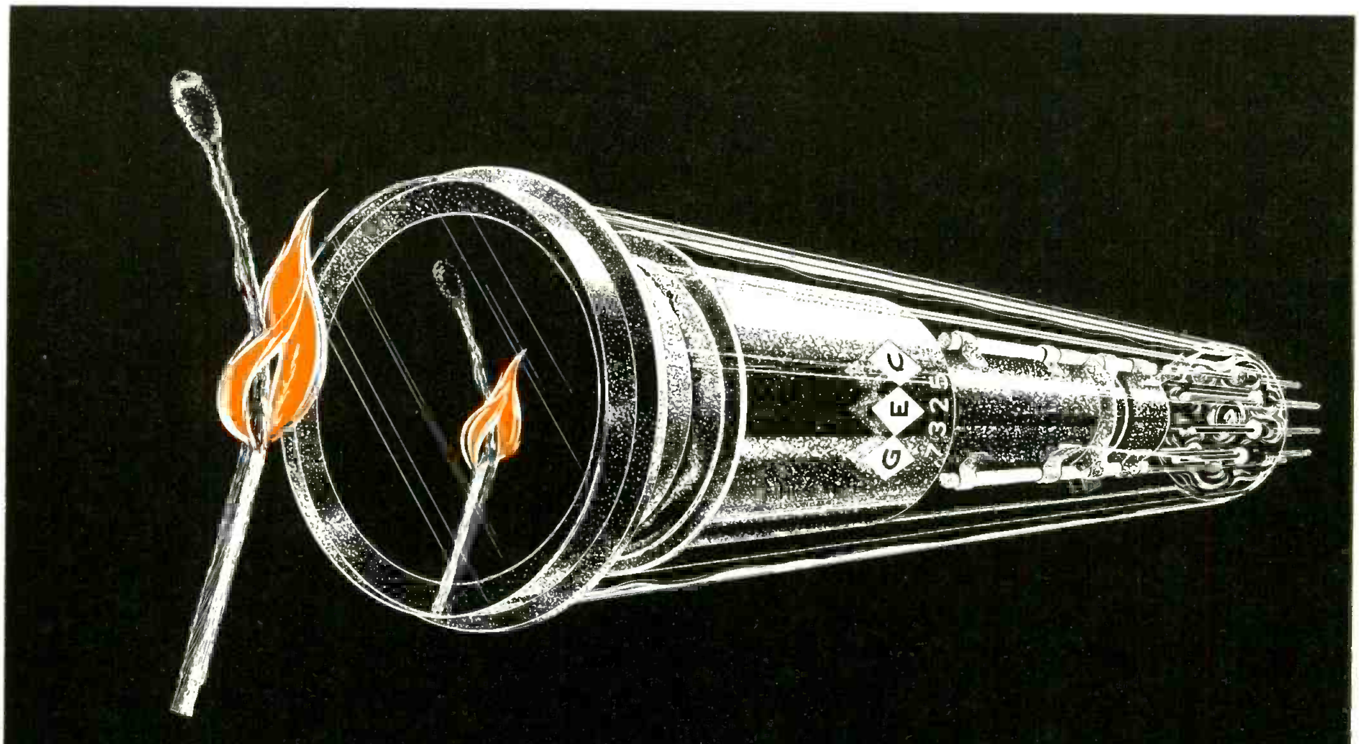

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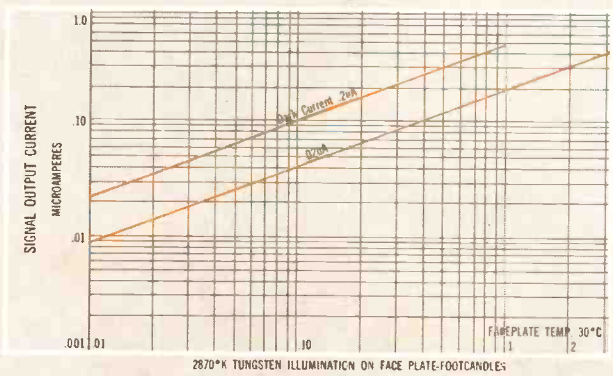

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Magnetic Amplifiers in Rolling-Mill Drives, Edmund Fiebig and Robert Joetten. "AEG Prog." #7, 1961. 7 pp. The application of magnetic amplifiers in combination with machines and rotary amplifiers for automatically controlled rolling-mill drives are described. (Germany in English.)

Magnetic Amplifiers for the Speed Regulation of Automatic DC Winders, Richard Floete. "AEG Prog." #7, 1961. 6 pp. Based on the characteristics of magnetic control and limiting amplifiers, the operation of automatically controlled dc winders is described. (Germany in English.)

MEASURE & TESTING

Acoustic Resonance Method for Analysis of Gaseous Mixtures, J. Kacprowski and T. Uthke. "Roz. Elek." Vol. 7, #1. 34 pp. The subject of this paper is the development of the acoustic method for measuring the volume composition of different gaseous mixtures. The method described is based on the measurement of the velocity of sound in the mixture under investigation. (Poland.)

Feasibility of Standards for Loss-Angle Tangent of Condensers, A. Jellonek. "Roz. Elek." Vol. 7, #1. 14 pp. The measurement of loss-angle tangent being a frequent operation carried out with a variety of instruments calls for the adequate standards which would enable to concert the records compiled from various sources. (Poland.)

Correlation Measurements Relating to Frequency Diversity in the HF Region, J. Groskopi, et al. "Nach. Z." March 1961. 5 pp. The correlation of the reception areas for different values of frequency spacing has been measured on an HF link Tokio—Frankfurt/-Main. The measuring arrangement and the method of evaluation are described. (Germany.)

A Genuine Double Pulse Generator, T. Friese. "El. Rund." April 1961. 2 pp. The generator and its application in measuring the resolution of coincidence, anti-coincidence and counting circuits is described. (Germany.)

Field Pattern Measurements of Various HF Directional Aerials Using Aircraft, R. T. Rye. "Proc. AIRE." Dec. 1960. 7 pp. Tests which established the actual field patterns of various full scale HAD (Horizontally Arrayed Dipoles), Thombic[2], Inclined Vee[3] and Franklin aerials at selected frequencies are described. (Australia.)

An Omegatron for the Quantitative Analysis of Gases, A. Klopfer and W. Schmidt. "Phil. Tech." #6, 1961. 9 pp. The present tendency towards high vacua of lower and lower pressures both in laboratory equipment and in electron tubes and other industrial products, makes it important to determine accurately the composition as well as the total pressure of the residual gas. Among the various kinds of mass spectrometer used for this purpose, the omegatron is particularly well suited—as this article describes—for determining, qualitatively and quantitatively, the composition of a gas at pressures lower than 10^{-5} mm Hg. (Netherlands, in English.)

Frequency Measurements of Damped Oscillations in the Presence of Interference, R. Giersiepen. "Freq." April 1961. 7 pp. After a basic comparison of the well-known frequency measurement methods with a view to the determination of the frequency of a damped wave, the paper describes the approaches taken for determining the period duration of the natural oscillation of the human arterial circulatory system from the time function of the blood pressure in the upper-thigh artery. (Germany.)

Determination of Required Frequency of Measurements in Discrete Control, E. L. Itskovich. "Avto. i Tel." Feb. 1961. 8 pp. A technique of calculation of a required frequency of measurements in discrete control of technological plants is described. (U.S.S.R.)

Some Recent Developments in Ultra-High Vacuum Technology, P. A. Redhead, E. V. Kornelsen. "Vak. Tech." March 1961. 9 pp. Various techniques developed for the production and measurement of ultra-high vacuum in small glass systems are described. (Germany.)

An Automatic Check-Out and Recording Network, R. Mansey. "Elec. Eng." May 1961. 8 pp. This article describes an existing British automatic check-out equipment designed for a missile system, which has proved suitable for any aircraft or similar system where the parameters are predominantly electrical. (England.)

A Torquemeter for Milling Investigations, J. L. Gwyther. "Elec. Eng." May 1961. 4 pp. A torquemeter for measuring the cutting torque on a milling machine is described. (England.)

The Measurement of Mechanical Oscillations Using Polarization Filters, Rudiger Hartwig. "Freq." March 1961. 11 pp. Part I: As a first step the fundamentals of this measurement method are stated; they are essentially in the field of optical techniques. Part II: The practical application of the measurement method is shown. (Germany.)

Solid-State Research at Low Temperatures. I. Introduction, J. Volger. "Phil. Tech." #6, 1961. 6 pp. The author has chosen a number of instances of the work being done in this field, at the Philip Laboratories and elsewhere, which will be presented in the form of three articles. It will be the aim in each subject discussed to explain why it is so important that the properties in question should be studied at low temperature. The first article which is an introduction to the subject, begins by considering what exactly is meant by low temperature. (Netherlands, in English.)

Performance of Simple Rectifier When Measuring Non-Sinusoidal Voltages, H. Gommlich. "El. Rund." April 1961. 6 pp. The author describes the properties of the well-known rectifier circuit for measuring purposes and the performance of such circuits when non-sinusoidal voltages are measured. (Germany.)

SEMICONDUCTORS

Transistorized Line Equipment for 12-Channel and "12+12" Channel Carrier-Current Telephone Systems, J. Aubert, et al. "Cab. & Trans." Jan. 1961. 21 pp. Substitution of transistors for electron tubes allows to simplify the building of carrier-current 12- and "12+12" channel telephone line equipment, resulting in noticeable cost reduction as compared with former systems. The authors study how the more or less complex structure of the equipment depends on the choice of repeater spacing. (France.)

Transistorized "12+12" Channel Telephone System with 6 kc/s Channel Spacing, G. Fuchs and J. Boulin. "Cab. & Trans." Jan. 1961. 18 pp. A new low-cost "12+12" channel carrier-current telephone system, with 6 kc/s channel spacing and transistorized equipment is described. (France.)

Minimal Clipping Levels of Semiconductor Clippers, M. E. Movshovitch. "Radiotek" 16, #4, 1961. 4 pp. Lowest possible clipping levels are determined for two-sided semiconductor clippers. The recommended methods of analysis can also be applied to vacuum-tube clippers. (U.S.S.R.)

Frigistors—Thermopairs Consisting of Semiconductor Material for the Use as Coolers and Heating Pumps. "El Rund." March 1961. 3 pp. Research in the field of semiconductors has lately resulted in the development of bismuth-tellurium compounds having an extraordinary Peltier effect. (Germany.)

Recombination of Injected Carriers in Transistors, H. U. Harten. "El Rund." March 1961. 4 pp. The paper indicates the cause of recombination and the effect upon current amplification in a conventional alloyed transistor. (Germany.)

A Transistorized Differential Equalizer. "Rundfunk." April 1961. 10 pp. Valve circuits for emphasizing, without phase distortion, the higher frequencies of the video signal have been known for some time. As part of the general trend towards the transistorization of video equipment, there has been developed a transistorized differential equalizer. (Germany.)

TELEVISION

Synchronizing and AGC Circuits in TV Receivers, E. M. Cherry. "Proc. AIRE." Feb. 1961. 16 pp. One of the problems associated with TV receivers is the designing of synchronizing circuits which will perform satisfactorily in the presence of noise interference. There are two fundamental methods for discriminating between signal and noise. The more powerful method depends on the redundancy of the synchronizing pulses; the AFC system for synchronizing the line oscillator is an example. This paper is concerned primarily with the method of amplitude discrimination. (Australia.)

The Modulation of Television Transmitters in the Intermediate-Frequency Stage. "Rundfunk." April 1961. 9 pp. The paper deals with problems of television-transmitter technique, the solution of which, by adopting the intermediate frequency and low-level modulation, results in a number of advantages from the point of view of transmission technique. (Germany.)

A Temporary NDR Television Studio at Hanover. "Rundfunk." April 1961. 3 pp. The NDR, in December 1960, took into operation at Hanover a temporary television studio, which is intended for interviews, topical reports and the like. It is planned to originate program contributions in this studio for a certain time and later to take it out of service. (Germany.)

A New Type of Television Systems. I. L. Valik, L. I. Chromoff. "Radiotek" 16, #2, 1961. 5 pp. The rising need and application of television methods of image transmission in various industral fields, scientific research etc., is closely paralleled with a development of new types of television systems. On the basis of previous works by the same authors, specific aspects are discussed of one of these new types of systems—systems with separated processes of recording and reading (small frame television). (U.S.S.R.)

Examining Image-Iconoscope Camera Tubes by Means of a Special Test Equipment, Albert Kaufmann. "Rundfunk." Feb. 1961. 8 pp. The paper briefly describes equipment for testing image-iconoscope camera tubes and shows its possibilities from the measurement point of view. (Germany.)

Characteristics of an Elementary Television Channel, P. M. Makovetzky. "Radiotek" 16, No. 4, 1961. 11 pp. Concepts of amplitude-frequency and frequency-frequency characteristics of an elementary channel are introduced. Discussed is a possibility of constructing a fundamentally new class of highly sensitive transmitting tubes which would not employ the principle of charge storage. (U.S.S.R.)

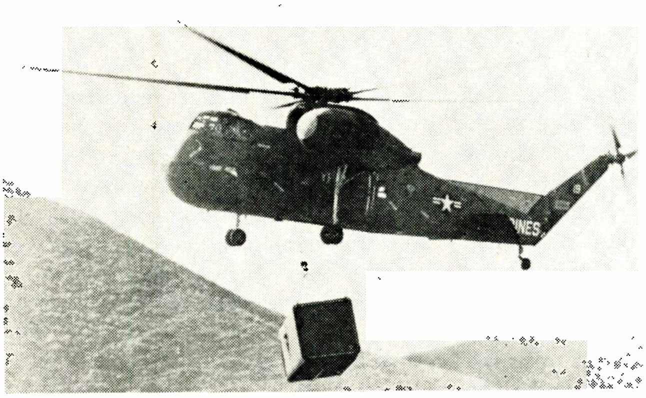
Tele-Tech's ELECTRONIC OPERATIONS

The System Engineering Section of ELECTRONIC INDUSTRIES · NOVEMBER 1961

SYSTEMS—WISE . . .

▶ TVA is having two digital computers installed to control its Paradise Station Units 1 and 2 near Drakesboro, Ky. The computers, manufactured by TRW Computer Co., div. Thompson Ramo Wooldridge Inc., will automatically control the turbine generators, sequence monitor the steam generators, and will sequence cold start, hot restart, normal shutdown, or emergency shutdown of the units. The system is built around the RW-300 Digital Control Computer.

HELICOPTER DEFENSE SYSTEM



In field training with U. S. Marines at Twentynine Palms, Calif., is America's first helicopter-transported air defense control system. The system provides ground troops with air defense by coordinating the firing of Hawk and Terrier guided missile batteries for the destruction of enemy supersonic aircraft. Developed by Hughes Aircraft Company's ground systems group, Fullerton, Calif., each system is installed in five plastic and aluminum shelters called "helihuts." Above, a helihut, transported as far as it can go by truck, is carried skyward by a Marine helicopter for movement to mountainous ground.

▶ New programming aid which minimizes time and effort needed to convert punched card machine operations to the solid-state IBM 1401 computer has been announced by IBM. The FARGO system compiles 1401 programs in less than 30 sec. for the automatic preparation of business reports. FARGO (Fourteen-O-One Automatic Report Generating Operation) is a "load and go" programming system.

▶ Dial-o-verter Systems which transmit data over regular telephone lines at speeds up to 1,500 words per minute, will have been installed in 17 cities from coast to coast by the end of the year, according to an announcement made today by the Digitronics Corporation. Dial-o-verter Systems have already been transmitting data, complete with verification, at a speed of 1,000 words per minute, utilizing punched paper tape equipment. New installations to be made shortly will include magnetic tape terminals, which will increase the speed of transmission to 1,500 words per minute. Installations which have been functioning for several months indicate a probable error occurrence in less than 2 out of 100 blocks. However, the Dial-o-verter System automatically detects and corrects all errors, resulting in error-free receipt of data.

▶ Brookhaven National Laboratory has ordered a digital data logging system built by Datex Corp., Monrovia, Calif., that will record data from experimental atomic energy research and warn of improper operation of equipment. The system will monitor all active input information, warn of any input point outside of preset limits and periodically record all input information.

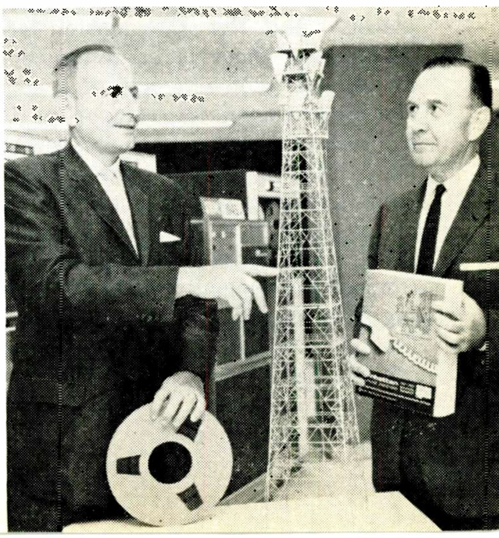
▶ TRW Computers Company, a division of Thompson Ramo Wooldridge Inc., has installed an RW-300 computer control system at the Tulsa refinery of DX Sunray Oil Company to perform on-line, closed-loop control of a new 85,000 barrel-per-day crude oil distillation unit. The new distillation unit replaces five older crude units that had a capacity of 75,000 barrels-per-day, it is the first major refinery unit to incorporate a computer control system in its original design. The RW-300 provides continuous and automatic control of the huge process-scanning 191 process instruments and adjusting 30 controller setpoints to maintain optimum efficiency. Such variables as temperatures, pressures, flow rates, and stream compositions are checked every 10 minutes and their readings are compared with predetermined limits stored in the computer's memory. Using this instrument data and a mathematical model of the process, the RW-300 exercises direct control over the distillation unit by automatically adjusting the appropriate controller setpoints.

▶ The General Electric Comp. has been awarded a $6 million contract to expand the facilities of the Southern Railway System. The new contract will double the Southerns use of the electronic communication system. The microwave network will be installed between Ohio; Atlanta, Ga.; and Birmingham, Ala.

The equipment will be battery operated, contributing to greater reliability as it will not be subject to transmission 'hits' associated with commercial power lines. These microwave installations replace telephone lines, and increase reliability as they are not vulnerable to snow and ice, and other bad weather.

SOLVING TIME AND DISTANCE PROBLEMS

A high-speed IBM Tele-processing system linking computer centers in Manhattan and Poughkeepsie, N. Y., was introduced by IBM and the New York Telephone Co. Here Warren C.Hume (holding magnetic tape reel), president of IBM's Data Processing Division, and Walter A. Giles, vice president of the New York Telephone Company, examine a model of a microwave tower similar to that used in the 68 air-mile transmission. Data is sent between the two IBM computer centers — in either direction or both ways at once — at a speed of 15,000 characters per second. This is more than 1,000 times as fast as human speech.



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Measurement of

A STANDING wave on a transmission line results from the combination of an incident and reflected electromagnetic wave. A portion of the incident wave is reflected whenever there is an electrical discontinuity, such as a dielectric bead or a change in dimensions, in the transmission line. A reflection also occurs if the line is terminated by a load that does not match the characteristic impedance of the line. Total reflected wave obtained is usually some combination of the load reflection and the small reflections resulting from the discontinuities in the line. The problem in most measurements is to accurately determine the reflections due to the load alone.

Standing wave measurements are often made by sampling the electric field along a transmission line. VSWR (voltage standing wave ratio) is taken as the ratio of the maximum to minimum voltage across the line.

Ratio of the reflected to incident wave is related to VSWR in the following manner:

$$\left[\frac{Vr}{Vi}\right] = \frac{VSWR - 1}{VSWR + 1}$$

It is necessary to connect the equipment or component under test to some measuring instrument when VSWR is to be measured. Thus a junction of two transmission lines is formed. At each junction or connection in a transmission line, a reflection is set up as there can never be a perfect lineup of two mating surfaces. In a wave guide system this problem can be reduced to negligible proportions. Inside dimensions of waveguide can be milled, ground or extruded to exacting dimensions, and the two flange mating surfaces can easily be made flat and perpendicular to the inside dimensions of each waveguide. Furthermore, there is no need for supports to be placed within the transmission medium since there is no inner conductor. A good example of a low reflection waveguide component is a precision milled slotted section body. Mating of two such components produces a maximum VSWR of less than 1.01 to 1 in X band. With coaxial lines, however, the connection is usually made by joining some standard connector on one line to a mating connector on the other line. These connectors require beads for support of the inner conductor and spring fingers, to provide contact between the inner and outer conductors on each connector. Buildups of tolerances permit only one of the conductor pairs to make a butt contact. The bead and the contact fingers at the junction between the measuring instrument and the test piece set up small reflections which combine with the reflection from the load, and create a serious problem in the measurement and ability to define coaxial line VSWR.

Types of Coaxial Line

Coaxial line can take many forms. Most common are rigid air line and solid dielectric cable.

In addition to the rigid air lines and solid dielectric cables there is a line that has an inner conductor positioned by six hollow dielectric tubes which are placed between the inner and outer conductors.

Table One

Rigid Air Lines

I.D. (Inches)	O.D. (Inches)	DESIGNATION (Inches)	Z_o
0.125	0.285	3/8	49.4
0.375	0.811	7/8	46.3
0.341	0.785	7/8	50.0
0.664	1.527	1 5/8	50.0
1.315	3.027	3 1/8	50.0
1.711	5.981	6 1/8	75.2
2.600	5.981	6 1/8	50.0

The resulting structure, called Spir-o-line, combines some of the features of rigid air line and cable. It is flexible, has a lower attenuation than an equivalent solid dielectric cable, and a higher power rating than an equivalent air line. Spir-o-line is manufactured as a 50 ohm cable in 3/8, 1/2, 7/8, 1 5/8 and 3 1/8 inch sizes.

Connectors and Adapters

Type N

Type N is the most frequently used coaxial line connector. It is a matched 50 ohm general purpose connector for small and medium size r-f cables, and is completely gasketed for weatherproof operation.

Curves showing the VSWR of several different mating pairs of connectors are shown in Fig. 2. These curves were obtained with a rigid 50 ohm air line attached to the input and output of the connector pair. Thus the results do not include the effects of any cable connection. Relatively low values of VSWR that occur for the mated pairs UG-21 A/U—UG-23 A/U and UG-21 B/U—UG-23 B/U from 7-10 KMC result from the fact that the reflection of one connector-half cancels the reflection of the other. If one of these connector-halves is not connected with the proper mating half, a reflection

By LEONARD O. SWEET,
Section Head,
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VSWR in Coaxial Systems

What are the different methods of defining and measuring coaxial VSWR? This article provides a simplified explanation. It lists the accuracy obtainable with presently available equipment and also brings to light the lack of standardization still present in the measurement and specification of coaxial VSWR.

cancellation will no longer occur and the VSWR will be higher than shown. Connector-halves of the D/U types are not dependent on this cancellation to any significant degree. Curves of VSWR for the connector pairs going from rigid line to RG-5/U, RG-9/U and RG-14/U cable are shown in Fig. 2. The corresponding cable connectors that were used were the UG-18 C/U, UG-21 D/U, and UG-204 C/U.

Type C

Type C connectors were primarily designed for medium size cables such as RG-5/U, RG-7/U, etc. They have a bayonet-lock coupling which permits fast connection and disconnection. Standard design of connectors has a peak voltage rating of 1000 volts, although several types with a 5000 volt rating are available. Rigid line to cable VSWR for a RG-5/U cable with a Type C UG-626 A/U connector, an RG-9/U cable with a Type C UG-573/U adapter, and an RG-17/U cable with Type C UG-708/U adapter are shown in Fig. 3.

BNC

BNC connectors were designed for small flexible cable such as RG-55/U and RG-58/U. They are small in size and have bayonet-lock coupling for fast connect-disconnect. All have a nominal voltage rating of 500 volts peak, and are gasketed for weatherproof operation. Rigid line to cable VSWR with a BNC UG-88 C/U and a UG-89 B/U as mating connectors is shown in Fig. 4.

Type HN

The HN connectors are high voltage (5000 volts peak) weatherproof connectors designed for use with medium sized cables. The high voltage design was based on increased leakage paths obtained by overlapping plug and jack dielectric beads, overlapping cable and connector dielectrics, and elimination of air pockets at dielectric interfaces through the use of Dow Corning No. 4 silicone grease. Maintenance of long leakage paths introduces impedance mismatches

Fig. 1. Curves showing the VSWR of several different mating pairs of type N connectors were obtained with a rigid 50 ohm air line attached to the input and output of the connector pair.

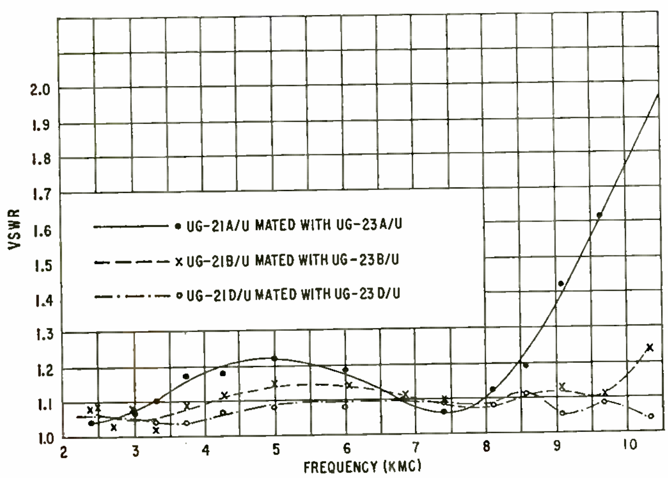


Fig. 2. Measured VSWR of type N cable connectors for connector pairs going from rigid line to RG-5/U, RG-9/U and RG-14/U cable.

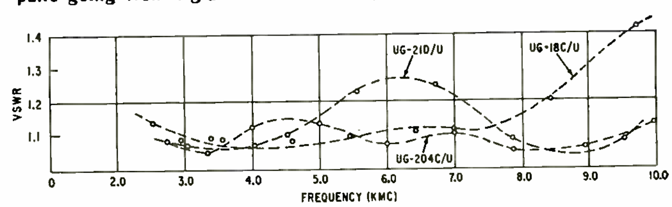
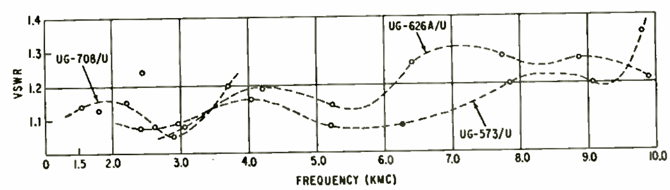


Fig. 3. Measured VSWR of type C cable connectors for connector pairs going from rigid line to RG-5/U, RG-9/U and RG-14/U cable.



DATACABLE

A COMPLETE SERIES OF DATA-PROCESSING AND TRANSMISSION CABLE

TIMES' Datacable is the first full line of engineered cable to meet every data-system requirement, and includes—

- Miniature low-capacitance coaxial cables.
- Low mutual capacitance twisted and multi-pair cables.
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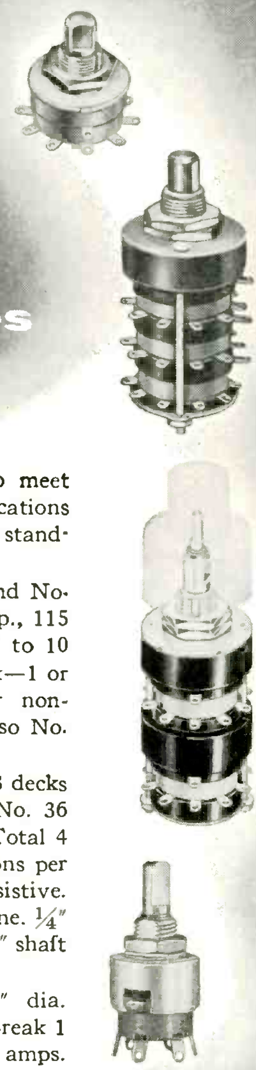
For Military and Commercial Applications

Grayhill Miniature Rotary Tap Switches



These switches are designed to meet military and commercial specifications and ruggedly built to precision standards.

Grayhill No. 5000, No. 12, and No. 24 Series. 1.01″ dia. Break 1 amp., 115 VAC, resistive. Carry 5 amps. 1 to 10 decks, 2 to 10 positions per deck—1 or 2 poles per deck—shorting or non-shorting. Life 100,000 cycles. Also No. 24 Series, spring return switch.

Concentric Shaft. No. 6 (1 to 3 decks per shaft—Total 6 decks) and No. 36 Series (1 or 2 decks per shaft. Total 4 decks). 1.01″ dia. 2 to 10 positions per deck. Break 1 amp., 115 VAC, resistive. Carry 5 amps. Two switches in one. 1/4″ shaft controls 1/2 of the decks, 1/8″ shaft controls the other half.

No. 45 Series Midget. .640″ dia. Single deck only. 60° indexing. Break 1 amp., 115 VAC, resistive. Carry 5 amps. Life 100,000 cycles.

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Grayhill offers a full line of Rotary Tap Switches, Push Button Switches, Test Clips, Binding Posts, and other miniature electrical and electronic components.

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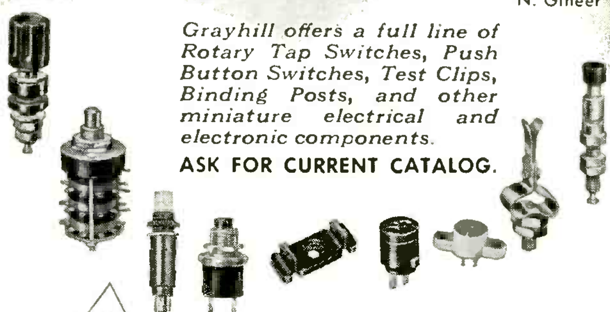

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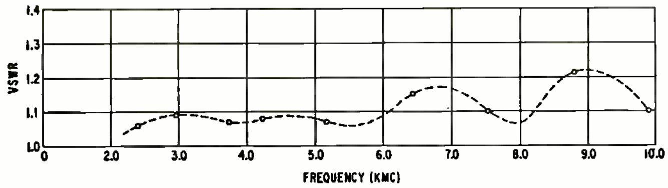


Fig. 4. Curve of rigid line to cable VSWR with BNC cable connectors.

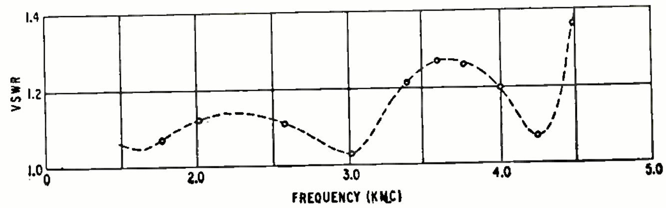


Fig. 5. Curve for rigid line to rigid line VSWR of the HN connector.

Measurement of VSWR *(Continued)*

which limit the upper frequency to about 4 KMC. A curve for rigid line to rigid line VSWR of the HN connector is given in Fig. 5.

Type LC and LT

LC and LT connectors are electrically similar, are weatherproof, and may be used in exposed locations. LC connectors were designed for large r-f cables such as RG-17/U and RG-19/U while the LT connectors were designed for the high temperature cables RG-117/U and RG-118/U.

Type UHF

UHF connectors are general purpose connectors for small and medium sized cables. They are not matched in impedance and therefore are not recommended for use above 200 MC. Maximum operating voltage is 500 volts peak.

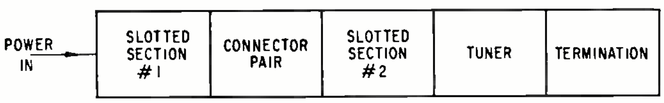


Fig. 6. Two slotted section method for measuring VSWR of a connector pair.

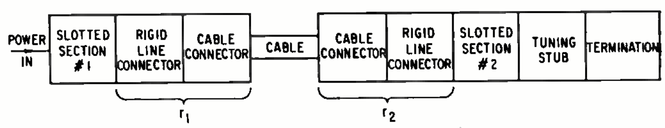


Fig. 7. Frequency variation method for measuring VSWR of a connector pair.

Miniature Connectors

Miniature connectors have not as yet been standardized and given military designations. Different types are available from the different connector manufacturing companies such as Industrial Products Co., Automatic Metal Products Co., Amphenol Electronics Co., and Microdot, Inc.

Adapters

There are many adapters that have been designed to permit the joining of one type of connector to another. Common types of straight adapters that are in use are best presented by Table 3. The number in a box common to two connector types is the adapter used to connect them together. Any number other than an RG number is an IPC designation.

Philosophy

From a practical point of view, the engineer is usually interested in obtaining VSWR data that will describe the performance of a component as it is to be used. He wants the measured VSWR to include the effects of any mating connector pairs since such mating pairs must be used if the component is to be connected to anything. VSWR information that is given may be measured with a standard connector pair, or without any connector pair.

The design of coaxial components cannot neglect the problem of connector reflection. Residual VSWR of connector is moderately high at microwave frequencies and constitutes a major difficulty if the design is to work over a wide frequency range.

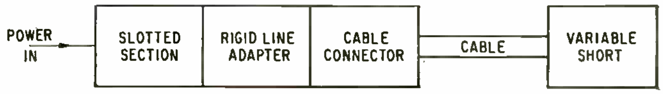
There are three common methods of measuring and specifying low VSWR coaxial components. One makes use of standard coaxial connector parts. It constructs the remainder of the components to provide cancellation of the reflections from the connectors at the frequencies of highest individual VSWR of each. Another makes use of special non-standard connectors. These contain special beads and usually require the use of a special mating connector for low VSWR. The third is just to neglect the connector VSWR, and state the VSWR of the component when measured in air-line. Unfortunately the designers of components rarely state which of the three methods has been used as a basis for the data and measurement of the component.

Philosophy for the first method is that the use of standard connectors is universal, and that VSWR of a component should be measured and stated as it is to be used in the field where it is mated with a perfect standard connector. Thus the user can always duplicate the measurement made by the manufacturers, and predict the actual VSWR of the component when it is placed in his system. It is usual for the VSWR specified by the manufacturer that uses this method to be higher than that of the manufacturer adhering to either of the other two philosophies.

Philosophy behind the other two methods is simple: Do not penalize the component because of the connector deficiency. Thus one group of manufacturers redesigns the connector making it special, and the other just neglects the connector entirely. The user cannot predict the VSWR of components made by manufacturers adhering to these philosophies. When placed in the user's system the VSWR of the component may be higher or lower than that specified. The federal government usually alleviates this problem by specifying that all connectors must meet MIL-C-71; the specifications for standard connectors.

(Continued on page 218)

Fig. 8. Sliding short method for measuring VSWR of a connector pair.



Measurement of VSWR *(Continued)*

Measurement of VSWR

VSWR information most commonly required is input VSWR of a one-port and the insertion VSWR of a two-port. These are usually measured through a rigid line to rigid line connector pair or a rigid line to cable connector pair.

At lower frequencies, where the connectors cause negligible effect, a slotted section or impedance bridge will measure the one-port input VSWR or two-port insertion VSWR with little error due to the connectors. At the higher frequencies the same measurement procedure is often used and the resulting total VSWR due to the component and its connectors is measured.

When VSWR of the one-port less its connectors is required, several methods are useful. In the first method the beads are eliminated and the unknown is connected directly onto the unbeaded output end of a slotted section. Special effort is made to ensure the butting of both inner and outer connectors. PRD Type 205A, N231, and 200 series of slotted sections make provision for this measurement. There is no bead at their output connector and the center conductor is cantilevered from the input connector bead. When the load is connected,

Table Two

Common Solid Dielectric 50 Ohm Cables & Connectors

Cable	Connector Type	Plug	Jack	Remarks
RG-5/U	N	UG-18 B/U, UG-18 C/U	UG-20 B/U, UG-20 C/U	Small microwave cable; double braid
	C	UG-626 A/U	UG-630/U	
RG-9 A/U	N	UG-21 B/U, UG-21 C/U UG-21 D/U	UG-23 B/U, UG-23 C/U, UG-23 D/U	Medium size circuit cable with high attenuation stability; double braid
	C	UG-628 A/U, UG-942 A/U	UG-570/U UG-632/U	
	HN	UG-59 A/U, UG 59 C/U UG-59 B/U, UG-59 D/U	UG-60 C/U, UG-60 B/U, UG-60 A/U, UG-60 D/U	
	UHF	PL259 A, NT-49195 PL259, NT-49190		
RG-17/U	N	UG-167/U, UG-167 A/U UG-167 B/U UG-167 C/U UG-167 D/U	14850 (IPC#)	Large high power, low attenuation transmission cable; single braid
	C	UG-708 A/U	UG-333 A/U,	
	HN	UG-495 A/U	UG-333 B/U	
	LC	UG-154/U	NT-49579	
RG-58/U	N	UG-536/U, UG-536 A/U	35025 (IPC#)	General purpose small size flexible cable; small braid
	BNC	UG-8 B/U, UG 88 B/U, UG-88 A/U, UG-88 C/U	UG-89/U, UG-89 A/U UG-89 B/U	
	TNC	79875 (IPC#)	79450 (IPC#)	
	C	UG-709 A/U	UG-704/U	
	BN	UG-245/U		
	HN	16750 (IPC#)	18325 (IPC#)	
	MB	45525, 49200, 61400 (IPC#)	45575, 48025, 48175 49225 (IPC#)	
RG-117/U	N	90400 (IPC#)		
	LT	UG-532/U	82-117 (Amphenol) 51325 (IPC#)	
	HN	UG-926 A/U		Semiflexible cable, for −55°C, to 250°C, single braid
	C	UG-711 A/U		
RG-196	(IPC) Subminax	27-30, 27-34	27-31, 27-35	Miniature cable, can be used to 200°C
	(Amphenol) MM	58300, 58425	54200 (IPC#)	
	Microdot	32-55 32-21, 32-23	31-34, 31-53	
	Automatic Metal Prod.	RF-3621	RF-3650	

the joined center conductor is supported by the slotted section input bead at one end and the unknown at the other end. Such a situation would arise, for example, when trying to measure the VSWR of an internal load for a coaxial directional coupler or a hybrid.

In the second method, the one port is connected to the slotted section by use of standard connectors. The remainder of the one port is made to slide longitudinally in the line. It is then moved until a maximum VSWR and then a minimum VSWR are obtained in the slotted section. Maximum VSWR is then the product of the VSWR's due to the component and the connector pair, and the minimum VSWR is their quotient.

From this information, and the knowledge of the shift of minimum position in the slotted section for maximum and minimum VSWR, it is possible to calculate the VSWR of the component. If the position of

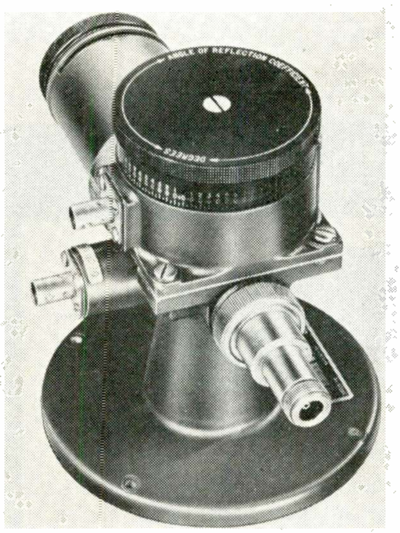


Fig. 9. Rotary Standing Wave Indicator shown is designed to cover range from 20 MC to 2 KMC with a residual VSWR of 1.03 or better.

the minimum shifts by one quarter wavelength from the maximum VSWR case to the minimum VSWR case, the VSWR of the component is greater than that of the connector pair.

Formulas for this calculation are:

For one quarter wave minimum shift

$$r_c = \sqrt{r_{max}\, r_{min}}$$

$$r_p = \sqrt{\frac{r_{max}}{r_{min}}}$$

For no minimum shift

(*Continued on page* 221)

WASHINGTON

News Letter

GENERAL ELECTRIC WITHDRAWS—The General Electric Co. has withdrawn its application to enter the satellite communications field through its specially-formed subsidiary, Communications Satellites, Inc. GE decided not to divert its resources in the carrier communications field but to concentrate on its "traditional role" as a manufacturer of space vehicles and allied equipment. The GE decision won praise from FCC Chairman Minow for the company's contributions of "scientific, technical, and other information in the fields of space technology and satellite communications." The FCC Chairman expressed the hope that the Commission "will continue to have General Electric's active participation in these matters in order that the important questions involved may be resolved expeditiously and wisely."

TV PROPOSAL—FCC Commissioner Robert E. Lee has proposed withdrawal of VHF televison channels in eight more areas of the country as well as speedy conversion to an all-UHF television system if the New York City tests prove the feasibility of such operations. The proposal would provide a plan to make available added frequency space for both the Bell System's program for a nationwide, broadband common carrier mobile radiotelephone network and for a variety of public safety, industrial, and land transportation mobile radio systems. The tentative Lee proposal for deriving 34 land mobile frequency channels in the eight areas has not yet gained adoption by the FCC, but is considered a precedent for future relief for the land mobile services.

SPACE ALLOCATIONS—The special CCIR study group of the ITU to be held in Washington next spring to consider the allocation of frequencies for space communication and other space purposes will precede the International Radio Conference scheduled to be held in 1963. ITU Secretary General Gross has stated that many of the attending countries with considerable influence on the ultimate results will not have an immediate requirement for frequencies for their own space activities. But, he stressed, they will have an interest in accommodating space needs on a basis that will not prevent the use of the same frequencies for ground or earth microwave purposes. Many of them will be concerned as to whether the large countries such as the United States and the Soviet Union use the lower microwave frequencies to cause significant interference with their own ground services.

National Press Building
Washington 4

ROLAND C. DAVIES

VSWR *(Continued)*

$$r_c = \sqrt{\frac{r_{max}}{r_{min}}}$$

$$r_p = \sqrt{r_{max}\, r_{min}}$$

where r_c = VSWR of component ess connector pair
r_p = VSWR of connector pair
r_{max} = Maximum VSWR produced by sliding component
r_{min} = Minimum VSWR produced by sliding component

A third method uses graphical analysis to obtain the reflection coefficient of a load as seen through a junction. The procedure was originally outlined by Deschamps and is described in the literature.[1, 2]

In many cases, the important data is that of the VSWR of the connector pair between rigid lines. To obtain this data, a sliding load of moderate VSWR is connected behind the connector pair. The above formulas are also applicable to this case.

The sliding load may be replaced by a sliding short that has its travel accurately calibrated. Graphical analysis can again be used to obtain the insertion VSWR of the connector pair "two port."

Still another method of measuring a connector pair between rigid air lines is the two slotted section method (Fig. 6). The procedure is to adjust the tuner until a match is seen with slotted section #2. Slotted section #1 then measures the connector pair VSWR.

It is more difficult to measure the insertion VSWR of a connector pair that connects a rigid line to a cable. Two methods that can be used are a frequency variation method (Fig. 7) and a sliding short method (Fig. 8).

The frequency variation method can be used to measure both r_1 and r_2 and thus determine the rigid line to cable VSWR for two connector pairs simultaneously. Actually, the method is more general and r_1 and r_2 can represent coaxial to strip line transitions or r_2 can be some termination whose

(*Continued on page* 222)

[1] J. E. Storer, L. S. Sheirgold, and S. Stein, "A Simple Graphical Analysis of a Two Port Waveguide Junction," *Proceedings of the IRE,* August 1953.
[2] S. Hopfer, "Precision Measurements with Slotted Sections," *PRD Reports,* Vol. 2, No. 3, October 1953, PRD Electronics, Inc.

Measurement of VSWR *(Continued)*

VSWR is desired. The line should have an electrical length greater than 50 times the length of the connector pair, and an attenuation less than 3 db. The procedure is to vary the frequency in steps and record the VSWR and minimum position for slotted section 1 with a match maintained in slotted section 2. Sufficient variation in frequency is used to establish a maximum VSWR value r_{max} and a minimum VSWR value r_{min}.

If the positions of the minimum for both maximum and minimum VSWR's are the same, then the VSWR of the connector pair at slotted section 1 is

$$r_1 = \sqrt{r_{max}\, r_{min}}$$

VSWR value for the connector pair at slotted section 2 modified by the attenuation of the cable is

$$r'_2 = \sqrt{\frac{r_{max}}{r_{min}}}$$

The actual value of r_2 is obtained from

$$r_2 = \frac{r'_2\,(1 + A) - (1 - A)}{(1 + A) - r'_2\,(1 - A)}$$

Where

$$A = \log_{10}^{-1}\left(\frac{\text{Cable attenuation in db}}{10}\right)$$

If the positions of the minimums are $\frac{\lambda}{4}$ apart, then

$$r_1 = \sqrt{\frac{r_{max}}{r_{min}}}$$

$$r'_2 = \sqrt{r_{max}\, r_{min}}$$

An assumption made in this measurement is that the phase and magnitude of the reflections of both connector pairs do not change for the small variation of frequency. The only change is in the phase from the reflection at slotted section 2 as seen at slotted section 1 through the long length of cable.

Block diagram for the sliding short method is shown in Fig. 8. Impedance at the end of the cable near the short is purely reactive and the reflection factor has a magnitude of unity and a variable phase that depends on the position of the short. The reflection factor at the other cable end has a variable phase and a magnitude of less than unity because of the attenuation in the cable which should be between 1 and 10 db. Position of the short is varied until a maximum VSWR, r_{max}, is measured and the position of the minimum recorded. The short is again varied until a minimum VSWR, r_{min}, is measured and the position of the minimum noted. If the minimum positions correspond, the rigid line to cable VSWR of the connector pair at the slotted section is

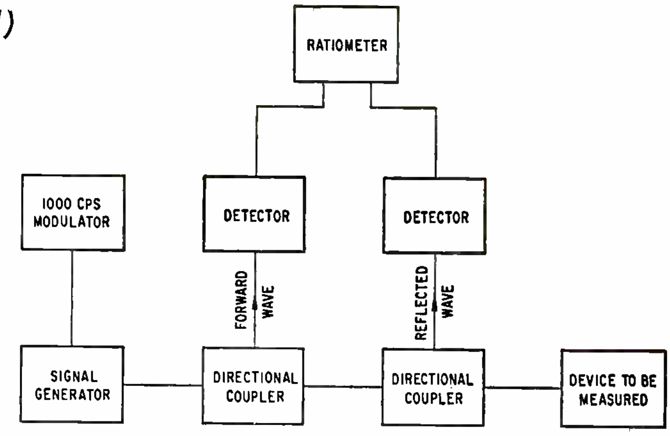


Fig. 10. Set-up for the measurement of VSWR by a ratio method.

$$r = \sqrt{\frac{r_{max}}{r_{min}}}$$

If the positions of the minima are a quarter wavelength apart,

$$r = \sqrt{r_{max}\, r_{min}}$$

Measurement Equipment

The most common method of measuring VSWR in a coaxial line is by use of a slotted section and a standing wave amplifier. Residual VSWR's available when using the slotted sections are usually 1.04 or better. The inaccuracy is usually due to reflections from the bead and irregularity in probe travel.

Commercial slotted sections are available to cover a range of frequencies from 50 MC to 12 KMC. Required length of probe travel is at least one-half wavelength at the lowest operating frequency. This ensures proper operation since the maximum or minimum position may fall in the center of the slotted section. Conventional slotted sections are large and cumbersome at low frequencies. For example, the

(*Continued on page* 235)

Table Three

Straight Adapters

	BNC MALE	BNC FEMALE	N MALE	N FEMALE	C MALE	C FEMALE	UHF MALE	UHF FEMALE	LC MALE	LC FEMALE	HN MALE	HN FEMALE
BNC MALE	UG-914/U		21850	UG-201/U UG-201A/U	84125	UG-636/U		UG-273/U			35050	
BNC FEMALE		UG-491/U UG-491A/U	UG-349/U UG-349A/U	UG-1034/U	UG-636/U		UG-255/U				32750	
N MALE	21850	UG-349/U UG-349A/U	UG-29B/U UG-29A/U			UG-565A/U		UG-83/U UG-83A/U	UG-270/U UG-271/U		16100	16050
N FEMALE	UG-201/U UG-201A/U	UG-1034/U		UG-57B/U UG-57A/U	UG-564/U		UG-146/U	UG-318/U			16075	
C MALE	84125	UG-636/U		UG-564/U	UG-643/U			UG-637/U	82350			UG-702/U
C FEMALE	UG-636/U		UG-565A/U			UG-642A/U					UG-703A/U	
UHF MALE		UG-255/U		UG-146/U			UG-299/U					
UHF FEMALE	UG-273/U		UG-83/U UG-83A/U	UG-318/U	UG-637/U							
LC MALE			UG-270/U		82350				UG-155/U UG-215/U		UG-217/U	
LC FEMALE			7750								UG-252/U	
HN MALE	35050	32750	16100	16075		UG-703A/U			UG-217/U	UG-252/U	11050	
HN FEMALE			16050		UG-702/U							16800

CUES for Broadcasters

An Inexpensive Remote

GLENN THOMAS, Ch. Eng.
KUSH, Cushing, Oklahoma

Many small stations with limited budgets need a remote unit which will handle records and provide speakers for the immediate area. A PA unit of about 15 to 20 watts, with a record table on the amplifier, is an inexpensive solution. Most of these amplifiers have a 4-8-16-500 ohm output. The speakers are connected as usual and the broadcast line is connected to the 500 ohm terminals. A mike input transformer and chassis mike connector to match your broadcast mikes is about all that is needed. We added a VU meter to ours for the convenience of the announcers.

I. O. Elapsed Time Meter

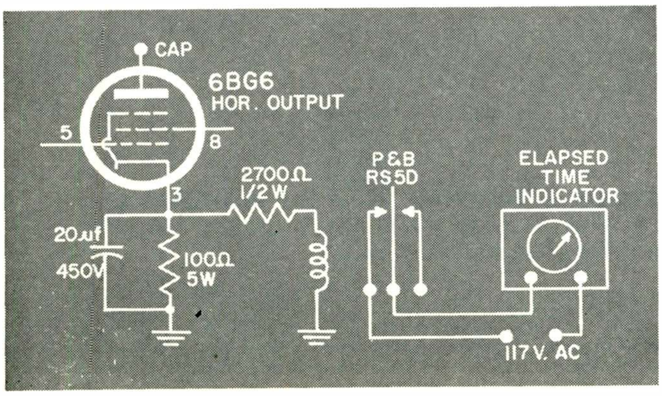
STEPHEN J. STANLEY, Studio Superv.
WAST, Albany, N. Y.

This is a modification we made in our General Electric 4PC4 and 4PC11 studio and remote cameras. It gives us a check on both filament and plate hours on our image orthicon camera tubes.

There was no problem encountered in installing the elapsed time meters for the filaments. This was done right at the power supplies by shunting the meters across the power switches.

The plate meters presented a slightly more difficult problem since it was desired to have the elapsed time meters at the cameras. We first contemplated changing the B + switch to a multiple pole switch, but this could not be done simply. Finally we found we could get 15 volts at the cathode of the horizontal output tube. The cathode resistor was a 5 watt, 100 ohm resistor by-passed by a 20 mfd. 450 volt electrolytic capacitor. This voltage which, of course, was developed when B + was turned on, was dropped to 6-8 volts with a ½ watt, 2700 ohm resistor. A Potter & Brumfield, Type RS5D, SPDT relay with a 6 vdc. coil was energized with this voltage, and the contacts were used to complete a 117 vac voltage across the elapsed time meter in the camera. The elapsed time meters used were Haydon Model ED71-001, and both meters and relays were mounted in the front of the cameras just under the r-f power supplies.

Circuitry used to determine plate hours on image orthicons.



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**

Summer Communications Program To Be Expanded

University of Colorado's department of electrical engineering will direct a regional communications engineering training center for 10 Bell System telephone companies and the Long Lines Dept. of the American Telephone and Telegraph Co. beginning next August. The course will be financed by the participating companies.

The University has conducted a Communications Engineering School for Mountain States Telephone Co. engineers during each of the last two summers.

Purpose of the school is to update and refresh the academic background and proficiency of practicing communications engineers. The 20 week course will be taught by full-time faculty members of the U. of C. electrical engineering department. Approximately 50 engineers will participate in each of the two sessions scheduled during 1962.

G. E. Graduate Awards

General Electric Co. has announced a new fellowship program and continuation of the honor program for University of Arizona electrical engineering graduate students.

G.E.'s engineering section in Phoenix will sponsor two master-degree candidates at the university for the 1961-1962 year. The candidates will receive $2,500 plus tuition and fees for M.S. work in one of the engineering sciences related to computer engineering. "This might involve information processing, logic design, transistor circuit design, work in special computer devices, or studies in the field of mechanical engineering directly related to the peripheral equipment problems," said C. C. Lasher, general manager of the Phoenix plant.

Graduate Studies Mandatory For Many Due To Recent Technological Advances

In July the national organization, Engineers Joint Council, said that freshman engineering enrollments had suffered a serious dip, starting in 1958. Since that time, they have declined 14 per cent.

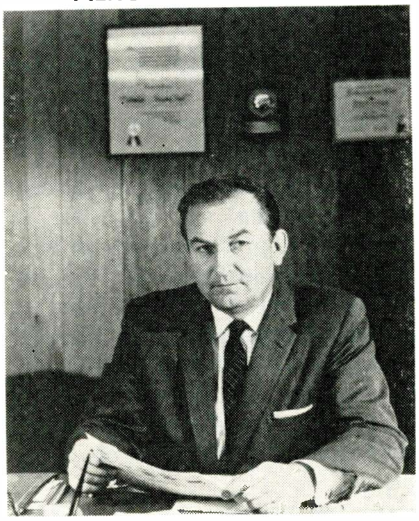
However, at Newark College of Engineering another largest-in-history freshman class has been enrolled this fall. Freshman number 586 as compared to 499 last year. Total enrollment in the undergraduate day division is also up, having reached 1,776. Last year's total was 1,610.

NCE's graduate division reported a similar upward swing. Chairman Irving P. Orens stated that a total of 726 students compared to last year's 650 are now enrolled in doctoral and master's programs.

Considering NCE's big graduate enrollment, Dr. Orens said he believed "the impact of recent advances in science and engineering, plus the acceleration of research in industry, defense and education, have made both doctoral and master's studies mandatory for many."

He said the world situation has intensified the need for qualified scholars, urging "young men and women into the frontiers of knowledge where they must transmit consequent advances to laboratories and classrooms."

AERO-SPACE AWARD



Walter J. Zable, president and chairman of the board of Cubic Corp., has been presented the annual San Diego Junior Chamber of Commerce Aero-Space Award. He was cited as the San Diegan who made the greatest single contribution to the aero-space industry during the last year.

Suggestion Award

An award of $56,000, believed to be the largest ever made through any employee suggestion program, has been presented to two employees of the IBM plant at Poughkeepsie, N. Y.

Equally sharing the award were technicians C. G. Glancey and L. R. Livigni for an idea which resulted in eliminating 14 printed circuit cards from a magnetic tape unit produced by IBM. The cards are used to package solid state transistors and other computer components.

Four to Share Scholarship

Four University of Colorado engineering students will share the $1,000 Boeing Aircraft Co. scholarship for 1961-62. The grant is made to students in engineering physics, applied mathematics, or aeronautical, electrical, mechanical, or civil engineering.

The four students are Robert Miller, Colorado Springs; Peter Teets, Denver; Charles McAfee, Lewis, and David Parkhurst, Webster City, Iowa.

FOR MORE INFORMATION . . . on positions described in this section fill out the convenient inquiry card, page 207.

NEREM '61–

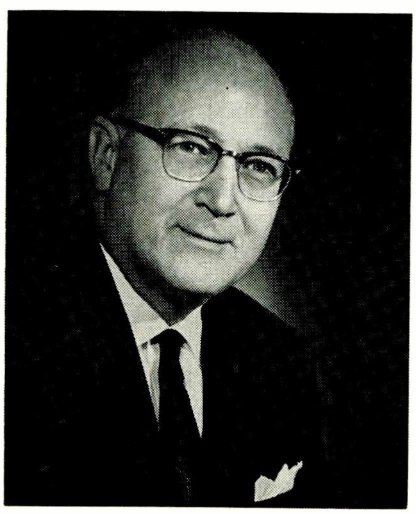
Microwave Clearing House

NEREM 61 will be held in Boston, Nov. 14-16, 1961. Technical sessions will be in the Somerset Hotel and the Commonwealth Armory; the latter is also the site of the exhibits.

In recognition of the contributions to electronics made by the citizen of Massachusetts and of the number of electronic scientists and engineers that will be attending NEREM, Massachusetts' Governor John A. Volpe has proclaimed Nov. 12-19, as Electronics Week in Massachusetts.

Over 25% of the 80 technical papers to be presented will be directly concerned with microwave theory and techniques. Some of these papers are highlighted at the end of this summary.

The meeting will open on Tuesday, Nov. 14, with the keynote speech being delivered by John L. Burns, President of Radio Corp. of America. His subject: "New Directions in Electronic Research".



The show has become so popular that the 420 exhibit booths were sold out within 2 weeks after the initial offering. These exhibits will occupy the entire floor of the huge armory. There will also be operational technical displays designed by the military, including the ADVENT communication satellite project, in special areas.

Among the distinguished guests at the meeting will be John L. Burns, RCA president, whose keynote address on Tuesday, Nov. 14, will be called New Directions in Electronic Research. The banquet speakers on Wednesday, Nov. 15, will be Gov. John A. Volpe and Charles H. Townes, Provost of the Massachusetts Institute of Technology.

All IRE members attending NEREM 61 will receive, at no additional charge, a letterpress conference report book—the NEREM Record—which will be about 200 pages. It will feature digests of every paper, supplemented by more than 300 key illustrations. Cost of the Record to non-IRE members attending the meeting will be $2.00.

Microwave Features

Since this is the 9th Annual Microwave Issue of Electronic Industries, we thought it fitting to highlight some of the microwave papers which will be presented at NEREM 61. Below is a capsule summary of the ones which we feel have special merit. The number preceding the name of the paper indicate the session and paper number.

Microwave Highlights of NEREM

3.1: Generation of Optical Harmonics
P. A. Franken, A. E. Hill
C. W. Peters, G. Weinreich
University of Michigan, Ann Arbor, Mich.

It has been recently discovered that the extremely intense beams of light provided by optical masers can be used to produce optical harmonics upon projection through suitable material. The physics of this phenomena will be discussed and recent developments described.

3.2: Further Investigations on Doped Calcium Fluoride Optical Masers
P. Sorokin
IBM Research Center, Yorktown, N. Y.

This report will discuss the results of spectroscopic studies of U + 3 ions in calcium fluoride and various types of sites. Additionally, spectroscopic studies of Sm + 2 in strontium fluoride will be reviewed and contrasted with calcium fluoride. Engineering considerations in techniques related to cw operation will also be covered.

3.3: Some Properties of a Gaseous Optical Maser
C. F. Luck, R. A. Paananen and H. Statz
Raytheon Co., Waltham, Mass.

The construction of a helium neon gaseous optical maser will be described. Some measurements on the output beam, including the results of photoelectric mixing experiments, will be discussed.

10.1: Varactor Diodes for Microwave Applications
K. E. Mortenson
Microwave Associates, Burlington, Mass.

A brief description of varactor microwave applications illustrating the various diode properties required will be presented. From this discussion, diodes of both the abrupt and graded variety made from different materials will be compared and evaluated.

***13.1: Linear Beam Devices**
T. D. Sege
Sperry Gyroscope Co., Great Neck, L. I., N. Y.

The unique advantages of linear beam devices for the generation of superpower will be reviewed with examples given of achieved and achievable peak and average power as well as "joules per jolt" as a function of frequency.

***13.2: The Cross-Field Approach to Microwave Super-Power**
W. C. Brown
Raytheon Company, Burlington, Mass.

The evolution of the cross-field device through the stages of the magnetron, The Commonwealth Armory in Boston is again the site of the exhibits.

This, the 15th, Northeast Electronics Research and Engineering Meeting will concentrate heavily on microwave—theory, components, and systems. Here's a capsule summary of what to look for.

the Amplitron and the new Electromagnetic Amplifying Lens (EAL) concept will be reviewed, with special emphasis on application to superpower generation. Efficiency anode dissipation capability, bandwidth, and pushing characteristics will be discussed.

17.1: Generation of Coherent Light
H. Statz
Raytheon Co., Waltham, Mass.

A discussion will be given of the maser principle and its application to the generation and amplification of coherent electromagnetic radiation in the wavelength region of visible light. In addition, a description of the various solid state optical masers, their relative advantages and disadvantages will be presented. Special emphasis will be placed on the gaseous maser which can be operated continuously.

17.2: Microwave Modulation of Light by the Electrooptic Effect
I. P. Kaminow
Bell Telephone Laboratories, Inc., Holmdel, N. J.

An experimental 10-kMc light modulator will be described and the properties of broadband, continuously operating electrooptic modulators discussed.

17.3: Microwave Phototubes and Light Demodulators
A. E. Siegman
Stanford University, Stanford, Calif.

This paper will discuss ways of receiving and demodulating microwave-modulated light, with emphasis on amplifying microwave phototubes and optical superheterodynes. A novel electronic method for detecting frequency-modulated light will also be proposed. Recent Stanford University experimental demonstrations of a traveling-wave microwave phototube and optical superhet receiver in connection with a ruby laser, will be reviewed.

17.4: Parametric Amplifiers—A Status Report
R. Adler
Zenith Radio Corp., Chicago, Ill.

Parametric amplifiers, of the diode type as well as the electron beam type, are now in use in many low-noise receivers. This paper will review their present state of development and emphasize the properties in which each type excels. It will also touch on some interesting sidelights, such as the use of purely degenerate operation in phase-lock and radar systems.

Massachusetts' Gov. John A. Volpe (center) hands K. C. Black, NEREM general chairman, the proclamation declaring the week of Nov. 12-19, 1961, Electronics Week In Massachusetts. Witnessing ceremony are Lewis Winner, consultant (left) and Stewart K. Gibson, exhibits manager.

18.3: The Hydrogen Maser
D. Kleppner
Harvard University, Cambridge, Mass.

The hydrogen maser has an inherent frequency precision significantly higher than previously possible with atomic resonance devices. This paper will discuss the behavior of the hydrogen maser in practice, with emphasis on problems which arise in attempting to utilize its precision and stability.

21.1: Semiconductor Microwave Control Devices
L. Gould, M. Bloom and R. Tenenholtz
Microwave Associates, Inc., Burlington, Mass.

The interaction of semiconductor junctions with microwave circuits to provide a new family of microwave control devices will be presented. The devices to be considered will be multi-pole multi-throw switches, duplexers, limiters, phase shifters and voltage variable attenuators and modulators. A general theory for the interaction will be presented and compared with typical experimental data.

21.2: The Application of Tunnel Diode Amplifiers
J. J. Sie
Micro State Electronics Corp., Murray Hill, N. J.

Low-noise tunnel-diode amplifiers are applicable to a wide variety of communications and radar systems. It will be shown that different tunnel-diode amplifier characteristics are of importance for different types of system applications.

21.3: Microwave Harmonic Generators Using Varactor Diodes
M. E. Hines
Microwave Associates, Inc., Burlington, Mass.

Varactor diodes are finding applications in frequency multiplier circuits for efficient transformation of energy from vhf to uhf to microwave frequencies. Advantages include high efficiency and crystal-controlled stability. Some circuits and their performance will be described.

21.4: Superconducting Magnets
S. H. Autler
MIT Lincoln Laboratories, Lexington, Mass.

Recently developed materials have permitted the fabrication of super-conducting solenodis which generate magnetic fields in the 20-30 kilogauss range, and give promise of considerably stronger fields. The properties and applications of these magnets will be discussed.

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*These discussions will be preceded by an introduction including a description of the two fundamental techniques presently available for the generation of superpower at microwave frequencies: Linear-beam and cross-field. The differences between these two approaches will be reviewed as a setting for the papers to follow.

New Tech Data for Engineers

Parabolic Antennas

Mark Products Co., 5439 W. Fargo Ave., Skokie, Ill., is offering tech. data on their parabolic antennas for point to point relay applications, and a condensed catalog and ordering information for communications antennas and associated cable systems. Outline drawings, photographs, and specs are included.

Circle 171 on Inquiry Card

Microwave Components

The Narda Microwave Corp., 118-160 Herricks Rd., Mineola, N. Y., has available their catalog which covers waveguide and coaxial attenuators, bolometers, thermistors, directional couplers, ferrite devices, ridge waveguide test equipment, special products and custom engineer devices. Included are photographs, outline drawings, descriptions, typical specs and uses.

Circle 172 on Inquiry Card

Microwave Towers

Tower Construction Co., 2700 Hawkeye Dr., Sioux City, Ia., is offering a tech catalog covering microwave towers, reflectors, buildings, and information on erection and maintainance and tower lighting kits.

Circle 173 on Inquiry Card

Backward Wave Oscillators

Stewart Engineering Corp., Santa Cruz, Calif., is offering tech data on their backward wave oscillators. Data covers 10 types of BWO's with specs on typical operation, average values, absolute min. and max. values, power output data, physical characteristics, and output connectors. Operating characteristic charts are included for each tube.

Circle 174 on Inquiry Card

Microwave Switches

Transco Products, Inc., 12210 Nebraska Ave., Los Angeles 25, Calif., is offering tech. data on microwave switches including motor actuated, solenoid actuated, DPDT, 8 r-f connector types, high and low power. Tech. data available about microwave components.

Circle 175 on Inquiry Card

Traveling Wave Tubes

Sylvania Electric Products Inc., sub of General Telephone & Electronics Corp., 1100 Main St., Buffalo 9, N. Y., is offering a catalog which describes 23 types of TWT's and backward-wave oscillators. Catalog lists characteristics and dimensions for PPM and solenoid-focused TWT's operating from 1 gc to 12 gc. Two permanent-magnet focused BWO's operating from 2 to 4 gc at 100 mw and 18 to 26.5 gc at 30 mw are also included.

Circle 176 on Inquiry Card

Microwave Oscillators

Trak Microwave Corp., sub. of Trak Electronics Co., Inc., 5006 N. Coolidge Ave., Tampa 3, Fla., has tech. data available on their miniature series L-band oscillators, SL-band oscillators, S-band oscillators, C-band oscillators, and C-band continuous wave oscillators. Photographs, dimensional drawings, characteristic charts and typical specs are included.

Circle 177 on Inquiry Card

Fixed Pad Attenuators

Applied Research, Inc., 76 S. Bayles Ave., Port Washington, N. Y., is offering tech data on fixed pad attenuators, terminations and impedance transformers (min. loss pads) for applications up to 2500 mc.

Circle 178 on Inquiry Card

Antenna Phase Systems

Scientific-Atlanta, Inc., 2162 Piedmont Rd., N. W., Atlanta 9, Ga., is offering tech information on their Model APA-1 antenna phase amplitude systems, for phase and amplitude determination of the electro-magnetic field over the aperture of an antenna. Operating freq. is 2 to 40 gc; high sensitivity —80 dbm at 13 gc, and phase accuracy and stability ±5° over 40 db dynamic range.

Circle 179 on Inquiry Card

Microwave Test Units

Polarad Electronics Corp., 43-20 34th St., L.I.C., N. Y. 1, N. Y., will send tech. data on their microwave test equipment which includes signal generators (ultra broadband extended range and extremely high freq.), microwave signal sources, Model CSG electronic sweep generator, and the Model TSA spectrum analyzer, the wide dispersion spectrum analyzer, Model TSA-W, and the multipulse spectrum selector, Model SD-1. Also included is a microwave receiver, calibrated field intensity receiver and meter, microwave test antennas, miniature S-band cavities, band pass filters, klystron power supplies, servo analyzers, coded multi-freeze generators.

Circle 180 on Inquiry Card

Cavity Amplifiers

Resdel Engineering Corp., 330 S. Fair Oaks Ave., Pasadena, Calif., is offering tech data on their line of cavity amplifiers and 10 amplifiers and freq. multipliers. Characteristics, charts, specs, outline drawings and photographs are included.

Circle 181 on Inquiry Card

Microwave Calorimeter

Chemalloy Electronics Corp., Gillespie Airport, Santee, Calif., is offering tech data on their Model SME-A ruggedized microwave calorimeter to measure/absorb microwave power.

Circle 182 on Inquiry Card

Ferrite Circulators

Microwave Development Laboratories, Inc., 15 Strathmore Rd., Natick Industrial Center, Natick, Mass., is offering tech information on 10 broadband balanced mixers with freq. ranges from 1.12 to 40.0 gc and vswr max. of 2.5 to 5.0. Also offered is information on 4 ferrite circulators with a freq. range from 8.5 to 9.6 gc.

Circle 183 on Inquiry Card

Waveguide Switches

Waveline Inc., Caldwell, N. J., has data on their direction couplers, their line of waveguide switches which cover from 3.95 to 40.0 GC and their line of waveguide slide screw tuners which cover from 5.85 to 40.0 GC.

Circle 184 on Inquiry Card

Microwave Absorber

Emerson & Cuming, Inc., Canton, Mass., is offering tech data on their standard foams, adjusted & artificial dielectric constant foams, rod and sheet stock, anechoic chambers and microwave chambers and wide angle radar reflectors (4 Luneberg Lens devices).

Circle 185 on Inquiry Card

Antenna Test Systems

Dunn Engineering Corp., 225 O'Brien Hwy., Cambridge, Mass., is offering tech. data on their dynamometer test stations for multiple evaluation of inertial gyro spin motors, radome and antenna test systems for automatic and manual checkout and test turntables.

Circle 186 on Inquiry Card

Waveguide Components

Microwave Components & Systems Corp., 1001 S. Mountain Ave., Monrovia, Calif., is offering a brochure on precision microwave components—standard items, covering the range from 1.70 to 40.0 gc. Included are E plane bends, H plane bends, variable attenuators, step attenuators, magnetic tees, ferrite isolators and standard gain horns.

Circle 187 on Inquiry Card

Microwave Tubes/Devices

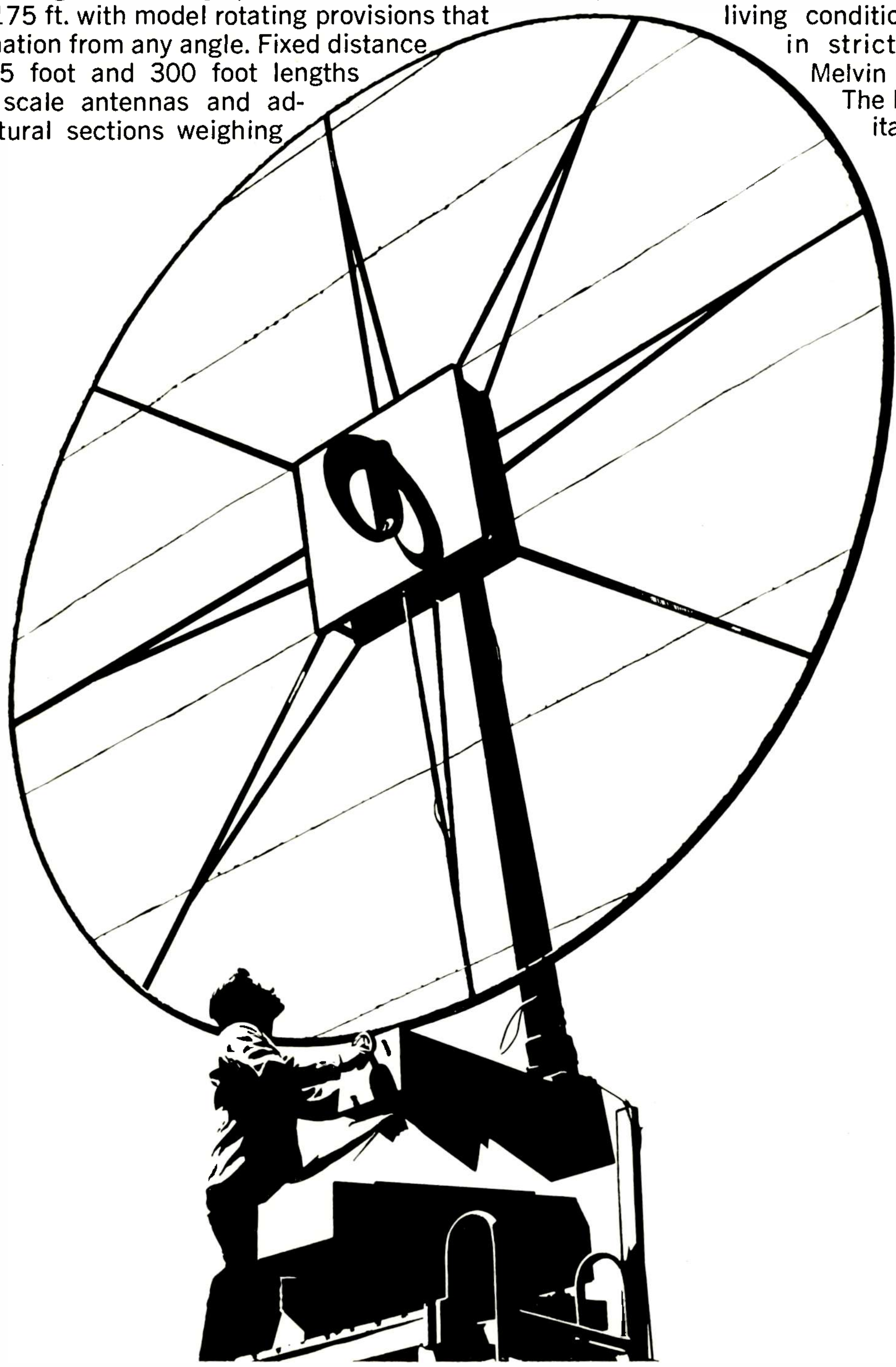
Microwave Associates Inc., Burlington, Mass., is offering the following microwave tech data: short form catalogs 61-MS semiconductor products; 61-WS microwave components, waveguide components and test equipment; 61-TD microwave tubes and devices, duplexers, magnetrons, ferrite devices; 61-CD computer diodes, subminiature, microminiature and computer diodes. Also offered is a 6-page article on solid state control and microwaves; a 12-page brochure describing microwave pressure windows and a semiconductor data filer containing 12 microwave diodes and 15 computer diodes.

Circle 188 on Inquiry Card

ELECTRICAL-ELECTRONIC ENGINEERS!

CHECK BOEING / WICHITA'S RESEARCH FACILITIES & CAPABILITIES

Experienced Electrical and Electronic engineers with the desire to express new ideas and theories and be given full recognition for their accomplishments will find the research facilities and atmosphere at Boeing/Wichita ideally suited for them. In the company's continuing efforts to expand research capabilities, they have assembled lab facilities that are among the best in the nation. • Just one example of facilities is the antenna system pattern ranges. Testing is done on three pattern ranges. One range provides variable distance up to 175 ft. with model rotating provisions that allow illumination from any angle. Fixed distance ranges of 75 foot and 300 foot lengths handle full scale antennas and adjacent structural sections weighing up to five tons. Signal emission sources and associated automatic antenna pattern recording equipment cover the low VHF to 75 KMC range. • Along with complete facilities the engineer will find that he will work with men who have knowledge of the most up to date theories and methods in the various related technologies. • To qualify you should have a degree with a minimum of five years experience and preferably be working toward or already have an advanced degree. For specific information about assignments and living conditions in Wichita, write in strict confidence to Mr. Melvin Vobach, Dept. OEN, The Boeing Company, Wichita Div., Wichita 1, Kans.



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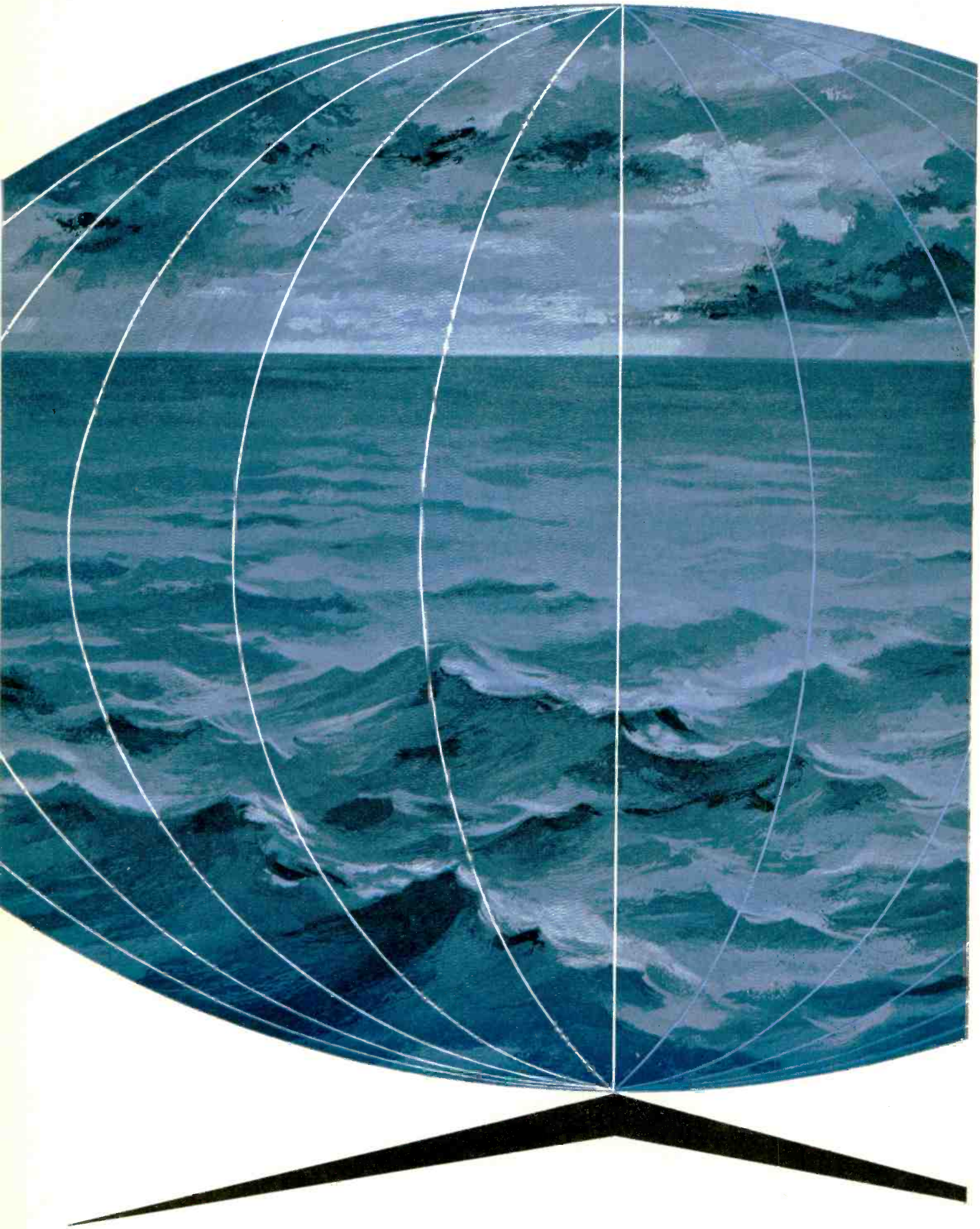

News of Mfrs'

Representatives

ERA Sales Training Seminar: Dec. 8-9

The Chicagoland Chapter of the ERA in cooperation with the Dartnell Institute will present a 17 hour course in Salesmanship for Electronic Representative Salesmen Dec. 8 and 9 at the Concord Motel, Chicago, Ill.

According to Seminar Co-Chairman Gordon Gray of Hill & Gray, Inc., and John Lightner of Lightner Assoc., Inc., applications will be on a first come, first served basis, up to a max. of 70 enrollees.

The course will be divided into two workshops. "A" for Audio and Distributor Salesmen. "B" for Industrial Component and Instrument Representatives.

Some of the subjects to be covered include: How to organize the sales facts; How to analyze your prospects; Howt to analyze your competition; How to make an effective presentation; How to make the best use of your time and talents; and How to set up and follow a program of self-improvement.

For further information contact Bob Morgan, ERA Director of Education, Electronic Representatives Assoc., 600 S. Michigan Ave., Chicago 5, Ill.

Industrial Devices, Inc., Edgewater, N. J., has been appointed national representative by the Sylvania Electric Co. for Sylvania's line of electronic indicator lamps.

University Loudspeakers, Inc., White Plains, N. Y., announces the appointment of **Butchart - Rathsburg & Associates,** Detroit, Mich., as representative for the state of Michigan.

Gulton Industries, Inc., Metuchen, N. J., announces the following representative appointments: **W. R. Griffin Co.,** Springhouse, Pa., to cover Pennsylvania; and **Long Associates,** Redwood City, Calif., to cover Northern California and Nevada.

Dynamic Industries Sales Corp., Detroit, Mich., appointed as representative by Sola Electric Co., Elk Grove Village, Ill., to cover the entire state of Michigan.

MELAPS, Palo Alto, Calif., announces the following representative appointments: **James R. Eberly Co.,** Washington, D. C. to cover Virginia, Maryland, and Delaware; **Instrument Dynamics Inc.,** Wakefield, Mass., to cover Massachusetts, Connecticut, Rhode Island, Vermont, New Hampshire and Maine; and **Perlmuth Electronic Associates,** Los Angeles, Calif., to cover California, Arizona, New Mexico and Nevada.

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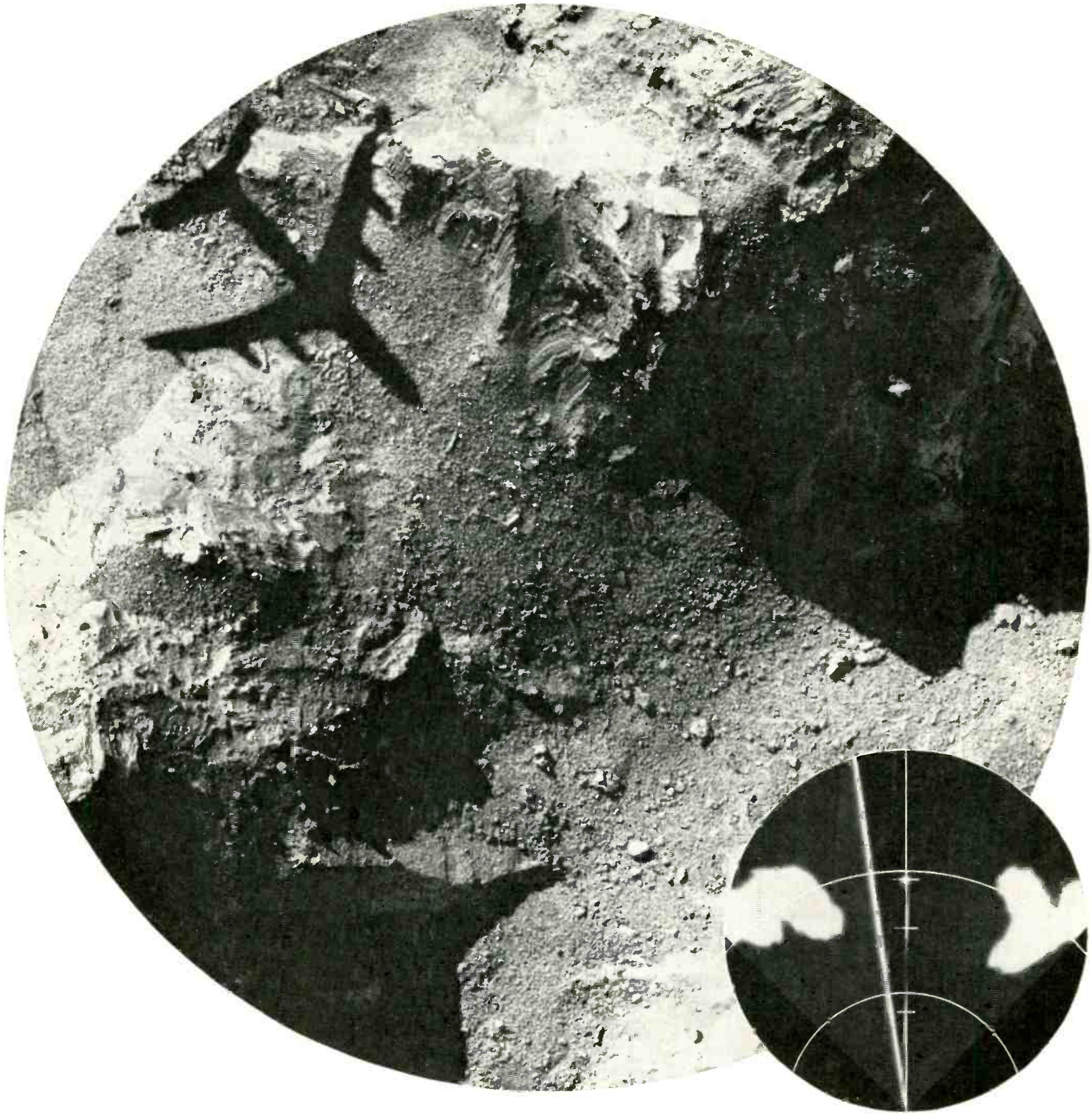

ENGINEERS ARE CHARTING A NEW COURSE AT AC

AC's newest assignment is Systems Integrator for the modified B-52C&D Bombing Navigation System. AC's responsibility includes program and engineering integration, and coordination of associate contractors in the production phase. ■ Other programs at AC include a new, miniaturized inertial guidance system for the TITAN II missile. In addition, AC's Los Angeles Advanced Development Laboratory is currently developing Advanced INertial Guidance Systems. ■ AC is seeking qualified men to work on these important projects. If you have a BS, MS or PhD in Electrical Engineering, Mechanical Engineering or Physics, please contact Mr. G. F. Raasch, Director of Scientific and Professional Employment, Dept. 5753, 7929 South Howell, Milwaukee 1, Wisconsin. An Equal Opportunity Employer. ■ Immediate positions available:

Milwaukee

Radar Systems Engineers • Radar Test Engineers
Radar Reliability Engineers • Design Review Engineers
Contact Engineers • Field Service Engineers

Los Angeles

(Advanced Inertial Guidance Systems—Airborne Computers)
Transistor Circuit Design Engineers
Sr. Digital Computer Development Engineers

■ AChiever Inertial Guidance Systems for TITAN II, THOR and MACE—Bombing Navigation Systems for the B-52C&D and B-47—AChieverfone mobile radiotelephones.

AC SPARK PLUG ⚛ THE ELECTRONICS DIVISION OF GENERAL MOTORS
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News of Mfrs' Representatives

Omtronics Mfg., Inc., Omaha, Nebr., announces the following representative appointments: **Florence & Meyer, Inc.**, to cover Missouri, Kansas and Nebraska; and **Lawrence Sales Co.**, to cover Texas, Oklahoma, Arkansas and Louisiana.

N.L.R. Associates, Philadelphia, Pa., appointed representatives by the Frequency Engineering Laboratories, Asbury Park, N. J., for Southern New Jersey and Eastern Pennsylvania.

Aerovox Corp., New Bedford, Mass., announces the following representative appointments: **M. D. Hecht Associates**, Phoenix, Ariz., to cover the state of Arizona; **Hyer Electronics Co.**, Englewood, Colo., to cover the states of Colorado, New Mexico, Utah, Wyoming and El Paso, Tex.; and **Snyder Electronic Distributors, Inc.**, Bayside, N. Y., for Metropolitan, N. Y.

Robert S. Schenck, has joined George H. Weiland to form **Weiland and Schenck Associates**, Flushing, N. Y., manufacturers' representatives in the New York metropolitan area.

Kitchen & Kutchin, Inc., Lexington, Mass. and West Hartford, Conn., named representatives for the New England states by Spectrol Electronics Corp., San Gabriel, Calif.

Tru-Ohm Products, Chicago, Ill., announces the following appointments: **Electronic Specialties**, Phoenix, Ariz.; **Radio Specialties Co., Inc.**, Alamogordo, New Mexico; **Kann-Ellert**, Baltimore, Md.; **Philadelphia Electronics**, Philadelphia, Pa.; **Ohio Valley Sound**, Evansville, Ind.; **Hughes-Peters, Inc.**, Cincinnati, Ohio; and **Ebinger Industrial Electronics Corp.**, St. Louis, Mo.

R. L. Pflieger Co., Inc., Palo Alto, Calif., named representative by Microwave Components and Systems Corp., Monrovia, Calif. to cover the West Coast.

Emory Design & Equipment Co., Birmingham, Ala., has been named sales representative of Wheelock Signals, Inc., Long Branch, N. J., for Wheelock's line of military and industrial relays.

John E. Fast Co., Chicago, Ill., announces the following representative appointments: **John O. Olsen Co., Inc.**, Cleveland, Ohio, to cover West Virginia and Western Pennsylvania; and **Ray Johnston Co.**, Seattle, Wash., for Northwest United States, including Washington, Oregon, West Idaho and Western Montana.

Radio Electric Service Co., Philadelphia, Pa., appointed distributor by Rotron Mfg. Co., Inc., Woodstock, N. Y., in Pennsylvania and Delaware.

(*Continued from page* 222)

probe travel on a slotted section that operates at 50 MC is about 10 ft.

A more convenient method for measuring VSWR at low frequencies, and one that is becoming very popular, is the utilization of the rotary standing wave machine. This device can be made quite small for use between 20 and 2000 MC.

PRD Type 219 Rotary Standing Wave Indicator (Fig. 9) is designed to cover the range from 20 MC to 2 KMC with a residual VSWR of 1.03 or better. This device consists of a rotating loop in a cut-off tube that probes the field generated by a coaxial "T" section. Leg of the "T" is fed by a generator. One arm is terminated in a unit positive susceptance and the other arm is terminated in the unknown. It can be shown that the resultant magnetic field generated at the "T" junction and propagated in the cut-off tube; and thus sampled by the loop, is elliptically shaped. The major axis is proportional to the maximum and the minor axis to the minimum of the VSWR that would result if the unknown were connected to a fifty ohm transmission line.

Another method of determining VSWR is the sampling and detection of the magnitude of the incident and reflected signals in a line by the use of directional couplers, and ratiometers. The experimental set-up is shown in Fig. 10. Outputs of the two detectors are fed to separate channels of a ratiometer which compares the two outputs and determines their ratio. Any errors caused by unequal couplings, detector sensitivities, or amplifier gains are compensated for by replacing the unknown load with a short circuit and adjusting the amplifier gains until a VSWR of infinity or a reflection coefficient of unity is indicated.

Accuracy of this method of measuring VSWR is usually limited by the directivity of the couplers. For example, a directivity of 30 db causes a residual VSWR of 1.06 and a directivity of 26 db causes a residual VSWR of 1.12. In order

(*Continued on page* 236)

VSWR

(*Continued from page 235*)

to approach the residual VSWR of a slotted section a directivity of 40 db (residual VSWR = 1.02) is needed. Commercial coaxial directional couplers are available from 25 MC to 1000 MC with directivities as high as 35 db. Below 120 MC the available couplers have couplings of 50 db or greater which makes their use inconvenient for low power laboratory measurements. Above 4 KMC the directivities decrease to less than 20 db.

At frequencies below 1.5 KMC, measurement of admittance or impedance is often substituted for the measurement of VSWR. There are various techniques for performing these measurements yielding accuracies of between 2% and 5%. The instruments involved usually make use of null techniques and are direct reading in impedance or admittance.

Main Errors

Because a slotted section is very frequently used to measure VSWR, main errors inherent in the use of a slotted section will be enumerated. These are residual VSWR, slope, and irregularities. Excluded from the discussion are probe and detector errors which are well referenced.

Residual VSWR of a slotted section is caused by the slight change in characteristic impedance due to the slot, and the discontinuities at the junction of the slotted and unslotted portion of the line. These effects are slight and can be approximately calculated. If one desires to experimentally measure the residual VSWR, there is a technique available for doing this.[3] The procedure is based upon the tangent method for lossless structures. It involves the tracking of the position of a minimum point in the slotted line as a function of the position of a movable short circuit which is used to terminate the slotted line. The short, however, should not be connected to the slotted line with a connector pair unless the effect of connector discontinuities is required to be in-

[3] A. A. Oliner, "The Calibration of the Slotted Section for Precision Microwave Measurements," *Report R-267-52, PIB-206*, March 1952, for Air Force Cambridge Research Center under Contract No. AF19(122-3).

cluded in the measurement of residual VSWR.

Slope can best be defined as a uniform change in detected output as a function of probe travel. It is independent of load or residual VSWR. Slope is caused by attenuation which causes a uniform diminution of the electric field along the line, and by a non-parallel movement (either vertical or lateral) of the probe to the center line of the coaxial line. Irregularities are caused by abrupt changes in probe travel or slotted section cross-section and are characterized by abrupt changes in probe output.

Theoretically, the error caused by the residual VSWR can be evaluated, but the combined effect of slope and irregularities can produce an uncertainty in the measured VSWR.[4] In actual practice, the combined effect of slope and irregularities is brought down to a VSWR of 1.01 or less on good slotted sections. Residual VSWR of

(*Continued on page* 238)

[4]H. E. Sorrows, W. E. Ryan, and R. C. Ellenwood, "Evaluation of Coaxial Slotted Line Impedance Measurements," *Proceedings of the IRE,* Feb. 1951.

(*Continued from page 237*)
most slotted sections, less the connectors, is also less than 1.01.

Conclusions

All too often a set of specifications will state that the VSWR does not exceed some maximum value but makes no mention of how the VSWR is defined or measured. This is particularly true for manufacturer's specifications of coaxial loads. Another common case occurs when a maximum VSWR is specified for a component that will ultimately be connected into a system by cables. What is really wanted is the rigid line to cable VSWR; what is invariably measured is the rigid line to rigid line VSWR; There can be a significant difference in these two types of VSWR if the frequency is high enough. A critical specification has little meaning unless the specification is clearly defined in terms of type of connectors used.

Acknowledgment

Much of the data contained in this report is based on the work performed at the Microwave Research Institute of the Polytechnic Institute of Brooklyn.

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More than 500 scientists and engineers will be hired during the next six months by Hughes Aircraft Company's Culver City Aerospace Laboratories. In addition to these specialists the company will hire several hundred electronic designers, draftsmen, and precision machinists.

The new personnel will raise the number of scientists and engineers at the Culver City facilities to about 2,600.

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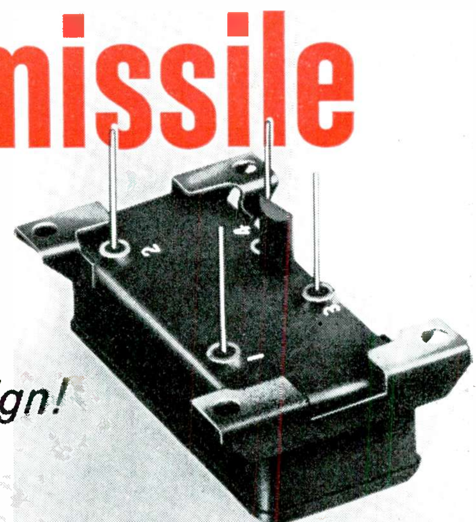

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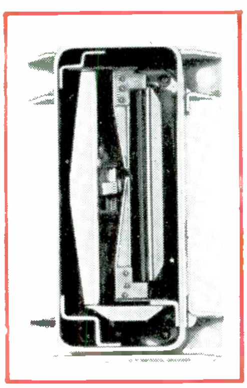

SPECIFICATIONS

Time Delay: 3 to 60 seconds (Factory Set)

Setting Tolerance: ±5% (±¼ sec. min.)

Temperature Compensation: Within ±5% over −65°C. to +125°C. range (±¼ sec. min.)

Heater Voltages: 6.3 to 115 v. for delays up to 12 sec.; 6.3 to 230 v. for longer delays.

Power Input: 4 watts. Rated for continuous energization at 125°C.

Contacts: SPST, normally open or normally closed. Rated 2 amps. resistive at 115 v. AC or 28 v. DC.

Write for Product Data Bulletin #PD-1015

Insulation Resistance: 1,000 megohms

Dielectric Strength: 1000 v. RMS at sea level. 500 v. RMS at 70,000 ft.

Vibration: Operating or non-operating, 20 g up to 2000 cps

Shock: Operating or non-operating, 50 g for 11 milliseconds

Unidirectional Acceleration: 10 g in any direction changes delay by less than 5%, 50 g by less than 10% with proper orientation.

Weight: 2 to 2¼ ounces.

G-V CONTROLS INC.
Livingston, New Jersey

G-V®

Circle 17 on Inquiry Card

RCA Microwave Devices

The RCA Microwave facility has recently received the "Reduced Inspection Quality Assurance Plan" award—by U. S. Army Signal Supply Agency—for a number of outstanding tube types. Here are additional types that will be of interest to you.

REPRESENTATIVE RCA MICROWAVE TUBES, SOLID-STATE OSCILLATORS AND AMPLIFIERS

LOW-NOISE SOLENOID AND PPM TRAVELING-WAVE TUBES (listed by Power-Frequency Ratings)

Type No.	Frequency Range (Mc)	Min. Power Output (Watts)	Min. Small-Signal Gain (db)	Max. Noise Factor (db)
A-1217*	1100-1400	0.0005	20	4.5
A-1217-V4*	1700-2000	0.0005	25	5
A-1119*	2000-4000	0.001	20	12
A-1207-V5*	2190-2310	0.001	20	4.5
A-1207-V10*	3500-4000	0.001	25	5
A-1139*	1000-2000	0.01	20	12
4019	1000-2000	0.01	28	17
4017	2000-4000	0.01	30	16
4020	4000-7000	0.01	28	18

PPM POWER TYPE TRAVELING-WAVE TUBES (listed by Power-Frequency Ratings)

Type No.	Frequency Range (Mc)	Min. Power Output (Watts)	Min. Small-Signal Gain (db)	Max. Noise Factor (db)
4009	2000-4000	0.01	33	—
A-1140*	8000-12000	0.01	33	—
A-1215*	12000-15000	0.01	30	—
A-1189*	4000-7000	0.1	30	—
4021	1000-2000	1	27	—
4010	2000-4000	1	33	—
A-1205*	4000-7000	1	30	—
4015	8000-12000	1	33	—
A-1225*	12000-15000	1	30	—
A-1093*	1700-2300	15	27	—
A-1160*	2000-4000	10#	25	—
A-1181*	7500-11200	25#	27	—
A-1136*	5000-6000	50#	30	—
A-1179*	2000-4000	80#	23	—
A-1134*	2000-4000	1000#	30	—

PENCIL TUBES (including Integrol-Cavity Types)

Type No.	Description	Max. Dimensions (in.) Length	Diam.
A-15131*	CW integral-cavity type for fixed-tuned oscillator service—300 mw useful power output. Variants available to cover 50 Mc intervals, 975-1225 Mc.	4.6**	0.98▲
A-15132*	Similar to A-15131, but for pulsed-oscillator service—500-watts peak useful power output.	4.6**	0.98▲
A-15227*	CW integral-cavity type for fixed-tuned oscillator service—300 mw useful power output. Variants available to cover 100 Mc intervals, 1800-2250 Mc.	2.5**	1.0▲
A-15228*	Similar to A-15227, but for plate-pulsed oscillator service—300 watts peak useful power output.	2.5**	1.0▲
A-15235*	CW integral-cavity type for fixed-tuned oscillator service—50 mw useful power output. Variants available to cover 100 Mc intervals, 3000-3450 Mc.	5.5**	1.0▲
A-15236*	Similar to A-15235, but for plate-pulsed oscillator service—50 watts peak useful power output.	5.5**	1.0▲
7552	For low-noise, Class-A service at altitudes up to 100,000 ft. without pressurization. 13 db min. power gain for 5 Mc Bw.	1.62	0.557
7553	Similar to 7552, but has additional performance and environmental features. 14 db min. power gain for 5 Mc Bw.	1.62	0.557
7554	For low-noise, class-C service at altitudes up to 100,000 ft. (at reduced ratings without pressurization). 1.6 watts power output at 500 Mc.	1.62	0.557
A-15205*	Similar to 7554, but for plate-pulsed oscillator service—250 watts peak useful power output.	1 5/8	9/16

Solid-State Oscillators

Type No.	Description
SS-100*	L-Band, mechanically tunable tunnel-diode type
SS-104*	L-Band, electronically-tunable tunnel-diode type
SS-107*	UHF and into S-Band, fixed-tuned tunnel-diode type

Solid-State Amplifiers

Type No.	Description
SS-500*	L-Band, tunnel-diode type
SS-1000*	S-Band helix-type parametric amplifier
SS-1001-V1*	S-Band helix-type parametric amplifier
SS-1002*	L-Band mechanically tunable low-noise parametric amplifier

Magnetrons (Pulsed-Oscillator Service)

Type No.●	Frequency Range (Mc)	Min. Peak Power Output (kw)	Tuning
6521	5400 ±20	75	None
7008	8500-9600	200	Servo
7111	8500-9600	200	Hand

*Developmental type #Peak ●With integral permanent magnet
**Excludes flexible leads ▲Excludes frequency adjustment screws and rf connector

Now Available! A 16-page booklet filled with technical data on nearly 100 different RCA Microwave Tubes and Solid-State Amplifiers and Oscillators. For your free copy, write on company letterhead to Section **K-50-Q**, Commercial Engineering, RCA Electron Tube Division, Harrison, N. J.

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